TROPICAL DISEASES BUREAU.

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DISEASES DUE TO PROTOZOAN PARASITES.

ALDIGÉ (E.). **Trypanosomiase du porc en Guinée française.** [Trypanosomiasis of the Pig in French Guinea.]—*Bull. Soc. Path. Exot.* 1920. Dec. 8. Vol. 13. No. 10. pp. 792–796.

Trypanosomiasis was described in pigs in French Guinea by MARTIN (G.) in 1906, and this author identified the parasite as *T. dimorphon*, although the long forms transmitted to the mouse are represented with a flagellum. Aldigé (now deceased) examined an outbreak of trypanosomiasis in a piggery belonging to a Mamou settlement in September 1914, during the rainy season. The outbreak appeared interesting on account of the rapid development of the disease, the extraordinary number of parasites in the blood of all affected animals, and the nature of the parasites. The animals were kept in a well-shaded place in a small valley. The only previously recorded occurrence of acute trypanosomiasis in the pig appears to be that of OCHMANN (*Berl. Tierärztl. Woch.*, 1915, May 11), who found the condition in a herd of pigs in German East Africa, and the trypanosome, for which the name *T. suis* was proposed, was said to belong to the *dimorphon* group.

Symptoms appeared suddenly and developed with extreme rapidity. The temperature exceeded 40° C. and sometimes reached 41° C. at the onset. The animal lay prostrate on its side, indifferent to its surroundings. The appetite was, however, maintained. Death occurred in untreated animals sometimes within 12 hours, but usually in from 24 to 48 hours. In all animals the disease assumed a hyper-acute or acute form. Thirteen pigs out of a lot of 22 died within six weeks. The mortality ceased a few weeks after the transference of the herd to higher ground. Post-mortem, the usual lesions of trypanosomiasis, viz., enlarged spleen and petechiae on the serous membranes, were observed.

The parasites swarmed in the blood in all cases during the first few hours of the disease. They were found in abundance in one pig which was in perfect health two days previously and then showed no trypanosomes in its blood, and had only shown the first signs of the disease six hours prior to finding the positive result. In all cases the number of parasites increased up to the time of death, so that eventually the blood was haemolysed and appeared to be a pure

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culture of trypanosomes. Fixation of smears was difficult. In fresh preparations the trypanosome exhibited more active wriggling movements than does *T. dimorphon*. It also showed some translatory movements which, however, were much less marked than with *T. cazalboui* (*vivax*), and it remained within the field of the microscope. After fixation and staining with Giemsa, the trypanosomes were generally slender, with long flagella. Some forms measured 12 to 14μ, others were 21 to 25μ long; the thickness was usually between 1 and 1·5μ. In the long forms the flagellum was much longer than in the short forms. Numerous intermediate forms were to be found. In some preparations short forms, reaching 2 to 4μ in width and possessing a very short flagellum, were to be seen, but these forms were very rare. A few very spherical-looking parasites were found composed of a protoplasmic mass with a flagellum, and containing a nucleus and a centrosome already divided into two. The majority of the animals had reached the agonal period when they were examined, and in these conditions the trypanosomes were extremely numerous, and undergoing division. Marked agglutination of the parasites was seen. Sometimes the posterior extremities of several parasites were attached to each other, and sometimes two or more were stuck together laterally for some distance. The posterior extremity was generally attenuated in the slender flagellated forms, and rounded in the short wide forms. The nucleus was situated at some distance from the posterior extremity in the former, but much closer in the latter. On morphological considerations the parasite is therefore not identifiable with *T. dimorphon* (*congolense*) or with *T. cazalboui* (*vivax*), but it appears to resemble more closely *T. pecaudi*, although the short forms observed do not correspond exactly with the typical short wide form without free flagellum of this species. The author considers that the parasite perhaps resembles still more closely *T. brucei*, although this species has not been found hitherto in French Guinea, but a closely-related form, *T. togolense*, has been found in Togoland. [We are not aware of any substantial differences between the three last-mentioned forms, and morphologically there is good reason for relegating this trypanosome to the so-called *brucei-pecaudi* group.—Ed.]

Experimental inoculations were not performed. One chronic case was observed in a sow, which showed rare trypanosomes only once in its blood. The animal became very thin, and developed paresis of the hind quarters and unsteady gait, with arching of the back. The appetite was maintained. This sow had been imported two months previously from a district where *T. pecaudi* is frequently encountered in several species of animals. It seems probable that this animal originated the infection in the herd.

Some of the pigs were submitted to treatment by the administration of orpiment, and 0·5 to 1 gm. daily of this drug for three days brought about the disappearance of the parasites. One boar, showing abundant trypanosomes in its blood, was given 1 gm. of orpiment, and on the following day the parasites were much less numerous, and short wide forms which were rare on the previous day appeared. The drug was then administered daily for three days in 2 gm. doses, after which the trypanosomes disappeared completely. Doses were then given twice only per week. The pig seemed to be cured, and treatment was dropped by the owner. The pig died suddenly, however, 19 days after the first attack. Another, a young sow, which was given

BRITISH MUSEUM

0·5 gm. of orpiment every day for three days, appeared to be cured and the parasites disappeared.

For three consecutive days orpiment was then given in doses of 0·25 to 2 gm. daily to the whole herd, according to the age and weight; mortality ceased and all the animals seemed to acquire good health. The author advised the administration of orpiment three times a week to the whole herd, but the treatment was not continued by the owner, with the result that a few deaths again occurred subsequently, from a fortnight to a month afterwards. The sow treated with orpiment succumbed suddenly about 20 days after the first attack.

Treatment with tartar emetic and orpiment was tried in another young sow: First day, 0·1 gm. emetic; third day, 0·5 gm. orpiment; fifth day, 0·1 gm. emetic; seventh day, 0·5 gm. orpiment; ninth day, 0·1 gm. emetic; eleventh day, 1 gm. orpiment; fourteenth day, 1 gm. orpiment, subcutaneously. Treatment was then discontinued. The parasites disappeared in two days after the first injection of tartar emetic and the animal recovered.

One sow, affected with a more chronic form of the disease, was treated with tartar emetic alone by the administration of four injections subcutaneously at three-day intervals of 0·1 gm. tartar emetic in 1 per cent. solution. Three months afterwards the animal was in good condition and its locomotor troubles had disappeared. The subcutaneous injection of this solution did not cause much disturbance in the pig beyond a transient, sometimes fairly marked, local inflammation. It did not produce large firm swellings, as the drug does in the horse, or any necrosis and sloughing, as in the dog.

HORNBY (H. E.). **The Relative Pathogenicity for Cattle of** *Trypanosoma congolense* **and** *T. vivax.*—*Vet. Jl.* 1921. Feb. Vol. 77, No. 2, pp. 77–78.

During 1920 Hornby had under observation on the Tanganyika Plateau a number of herds of native cattle affected with trypanosomiasis. Examination of one affected herd in particular showed that the animals varied in condition, some being in an excellent state of fitness and others emaciated. It appeared that although many cattle had died, a number of those in good condition at the time of examination had been sick and had recovered. Several affected cows aborted or gave birth to weakly calves, but if the beast were young and the grazing good she might again pick up in condition and rear her calf. Some recovered animals suffered from relapses and died.

The blood and gland juice of 30 cattle affected with the disease or said to have recovered were examined microscopically. No trypanosomes were found in any beast which did not show clinical symptoms of the disease, even when it was said to be a recovered animal. Sixteen cows were found to harbour trypanosomes; 10 of these disclosed *T. congolense* (in gland juice only 1, in blood only 2, in both blood and gland juice 7); six harboured *T. vivax* (in gland only 3, in blood only 1, in both blood and gland 2). It would thus seem that *T. vivax* infection can be overlooked when the blood only is examined. The glands usually examined were the prescapular glands.

Four young cows affected with *T. congolense* and four affected with *T. vivax* were picked out and left under the ordinary conditions of village management at the time of the year when grazing was still

plentiful. Three months later all four *T. congolense* animals were dead. Of the *T. vivax* animals one had died, one was very thin (with blood and gland juice positive), and two appeared to have recovered. In order to test the immunity of these two recovered animals they were injected subcutaneously with blood rich in *T. vivax*. Eight days later they were decidedly ill and their blood was heavily infected.

A heifer in good condition, but stated to have been ill and aborted a year previously, was injected with two strains of *T. congolense*, with the result that she rapidly became diseased and died a month later.

Hornby therefore concludes that in some districts a number of native cattle recover spontaneously from *T. vivax* infection, but that no high degree of immunity results therefrom.

PUNJAB. **The Annual Report of the Camel Specialist** [CROSS (H. E.)] **for the Year 1919-1920.**—11 pp. 1920. Lahore: Supt. Govt. Ptg. [Price R.0·3 or 4*d.*]

The laboratory of the camel specialist was re-transferred from the Military Department to the Civil Authorities on September 1, 1919.

Courses of training were given to Sarwans from various camel corps, and 80 camels belonging to private owners were treated during the year for various diseases.

Surra Treatment.

Some experiments on the treatment of surra in camels by means of tartar emetic were carried out by Cross in the early part of 1917 (see this *Bulletin*, 1920, Vol. 8, p. 179).

Further experiments carried out on a large number of camels during the cold weather of the year under report are claimed to have furnished the following results:—Ten doses of 60 cc. of a 1 per cent. solution given intravenously to full-grown camels of average size do not effect a cure in the majority of cases. Likewise one large dose of 600 cc. of a 1 per cent solution, given intravenously in three injections of 200 cc. each with two or three-hour intervals between the injections, did not result in a cure. On the other hand, ten to twelve doses, given on alternate days, commencing with 150 cc. of a 1 per cent. solution and increasing to 300 cc., gave very promising results. However, it is admitted that these camels must be kept under observation for a period extending over at least a year and their blood tested by inoculation into small animals before it can be claimed that an actual cure was obtained. It was found that fainting was not so liable to occur if the first injection of tartar emetic was given when the trypanosomes were absent from the peripheral circulation, that is to say, when the temperature was not high. The action of antimony trioxide and other drugs in surra treatment is said to be under investigation.

Some remarks are made with regard to the course that surra, either naturally or artificially contracted, runs in camels. Many Punjabi camel men maintain that camels, once infected, never recover, while, on the other hand, many camel men are of the opinion that if the infected animal lasts over three years it finally recovers, improves in condition, and finally becomes immune towards the disease. To ascertain the course that surra runs in camels when it is naturally contracted 11 camels suffering from surra and in fair condition were obtained from the Sillader Camel Corps in the latter part of 1914 and early part of 1915,

and it seemed that these animals had contracted surra during the 1914 fly season. They were kept under most favourable conditions, submitted to no work, and, in addition to browsing, given a ration of grain and bhoosa. The blood of each camel was examined daily and a record kept of the presence or absence of trypanosomes. Up to the end of the year under report (March 31, 1920) ten out of the 11 camels had died, and the surviving animal was in poor condition and likely to die during the next period of cold weather.

In addition to these 11 camels seven other camels belonging to a villager who lived near Sohawa were diagnosed on September 29, 1913, to be suffering from surra. During the cold weather these seven camels were worked by the owner in the Ambala and Amritsar districts, but during the hot weather they were not worked. Within 1½ years two males had died and the dachi had aborted ; within 2½ years five had died ; in less than 3 years all seven had died.

In order to ascertain whether there is any difference in the course of the disease when it is contracted by artificial inoculation, four young camels aged from 2½ months to 1 year and one camel aged 18 years were inoculated with 1 cc. of infected blood. The camels were kept under the same conditions as those that had naturally contracted the disease and the blood was examined daily. The 18 years old camel died 18 days after the inoculation, but the four young camels were all alive and in fair condition on March 31, 1920. In other words, three one year old camels were still alive after four years five months and eleven days, and one 2½ months old camel after two years ten months and four days.

Cross concludes that the time an infected camel lives probably depends to a great extent upon the age at which it becomes infected. Further, it is unlikely that camels infected after the age of six years and worked ever recover from the disease. Whether animals that become infected when they are very young recover still remains to be ascertained.

In the early stages of surra the paroxysms were, in the majority of cases, far more frequent than in the later stages, and in the later stages diarrhœa was a frequent symptom. Mange produced very rapid loss of condition in the infected camels. Swelling and suppuration of the inguinal glands were frequently seen. Stall-fed camels often fed well even during the paroxysms, but when they were out browsing during the paroxysms they did not feed well, did not go from tree to tree like a camel in normal health, and were obviously sick. Oedema of the belly and legs was sometimes seen.

During the investigations into surra amongst the Camel Corps and other military camels it had often been noticed that ponies and mules kept in close proximity to a large number of camels suffering from surra during a fly season exhibited practically no cases of the disease. It appeared possible that the ponies did not become infected, or that they did not develop the same symptoms when infected with camel surra as when they were suffering from horse surra. It was decided, therefore, to ascertain the course camel surra runs in ponies and other animals, and with this object in view ponies, buffaloes, goats, sheep, dogs, rabbits and guinea-pigs were inoculated with blood from infected camels.

Ten ponies of various ages were inoculated. Two ponies, one aged 1 year and the other 6 months, were alive when reported upon over three years after inoculation ; one, 8 months old, died in just over

2½ years, while the others, which varied in age from 3½ to 18 years, succumbed at intervals extending from 43 days to 1 year 5 months from the time of inoculation. The results appeared to show that infected ponies do not often lose condition, and do not always die from gradual emaciation. On the contrary, they frequently put on condition and live for several years when not made to work. In some cases in the later stages of the disease the intervals between the paroxysms were very long, extending to more than a year. Constipation, colic, partial paralysis of the hind-legs and brain symptoms were frequently met with. Death from paralysis of the hind-legs has been reported in ponies attached to camel corps, and it is therefore not impossible that such animals died from camel surra.

Six buffaloes, three 5 years old, three 6 years old, were inoculated with infective camel blood and did not die from surra, and trypanosomes did not frequently occur in the blood. Even when no trypanosomes could be found in the blood, it could, nevertheless, be demonstrated to be infective. In two buffaloes the blood was infective for rabbits and guinea-pigs when tested 163 and 172 days respectively after the inoculation. This distinctly proves that buffaloes can act as dangerous reservoirs of surra; it was noted that Tabanidae were frequently seen sucking the blood of these animals. The buffaloes did not lose condition after the inoculation.

Dogs (five inoculated) showed very little resistance to the disease, and died within two months. They became greatly emaciated, and showed a great tendency to develop eye lesions.

Two goats were inoculated, and did not subsequently die, although they were kept under observation for 999 days. They did not lose condition, and trypanosomes were seldom found in their blood. They were only found once in one animal, 107 days after inoculation. The blood, nevertheless, could be demonstrated to be infective, for blood taken from one goat 309 and from the other 321 days after inoculation proved virulent.

Sheep (five inoculated) proved susceptible to inoculation, but trypanosomes were very infrequently found in the peripheral circulation, although the blood could be demonstrated to be infective by inoculation. The sheep became gradually emaciated as the result of the disease, and finally died. Sheep and goats, however, are not such dangerous reservoirs of the disease as buffaloes are, for they are seldom attacked by Tabanidae. Camel surra gave rise to a fatal infection in guinea-pigs and rabbits. The rabbits (two) succumbed in 180 and 84 days respectively; the guinea-pigs (three) in 17, 75, and 68 days respectively.

An examination of all privately-owned camels throughout the Punjab has been commenced, with a view to ascertaining the number infected with surra, as this result should be capable of furnishing some idea with regard to the percentage infected in the Province, and also of the areas where surra is most prevalent.

Breeding of camels has decreased, greatly owing to the fact that large areas of rakhs have been closed up by forest legislation, and extensive tracts of land which were previously available for this purpose have been reclaimed by the Canal Department. It is maintained that unless steps are taken for the encouragement of camel breeding, it will be very difficult in the future for the Military Authorities to obtain sufficient remounts for the Camel Corps. The Punjab *pahari* camel, which is the most suitable for frontier work, is becoming very scarce, and steps should be taken to prevent this type of camel from becoming extinct.

WATSON (E. A.). **Dourine in Canada, 1904–1920. History, Research, and Suppression.**—Dominion of Canada, Dept. of Agriculture, Health of Animals Branch. 43 pp. With 9 plates (2 coloured) and 14 charts. 1920. Ottawa: Thomas Mulvey, Printer.

In this interesting monograph Watson presents a succinct account of Canadian experience with dourine, an experience extending over a period of 15 years, and covering the study and suppression of a rare and serious disease previously unknown in Canada. It is well to bear in mind that although the disease is one of the oldest recorded in veterinary literature, and has been known to the Arabs and in certain countries of Asia and Africa for centuries, it is only within the past 25 years that its nature has been recognised.

The causal agent, *Trypanosoma equiperdum*, was seen for the first time by ROUGET in 1894. The specificity of this parasite was for a long time, however, contested by many workers in Europe, and the question was still in dispute ten years later, when the disease made its first appearance in Canada. In March 1904 Inspector BURNETT, Chief Veterinary Officer of the Royal North-West Mounted Police, reported the existence of the disease in a stallion and several mares located near Lethbridge, Alberta. The Veterinary Director-General (RUTHERFORD), HARGRAVE of Medicine Hat, DAVISON of the United States Bureau of Animal Industry, and other veterinarians, examined the affected animals and agreed upon the diagnosis. From inquiries made in the neighbourhood, it appeared probable that the disease had been introduced several years previously, and there appears to be good reason to attribute its introduction to the importation of animals from the Western United States, where among range animals the disease had been known to exist from time to time.

A quarantine station of 1,800 acres of fenced land was thereupon established near Lethbridge, where all suspected animals were gathered in and kept under observation. Regulations relating to the disease were formulated and brought into force under the provisions of the Animal Contagious Diseases Act, 1903, and slaughter of infected animals and payment of reasonable compensation to owners were enacted. The quarantined animals were re-examined after a period of several months, when it was anticipated that acute or well-marked symptoms of the disease would have developed. RUTHERFORD reported that, instead of finding an aggravation of symptoms and a progressive state of disease, he was surprised to discover that there were no well-marked cases, that many of the affected animals had greatly improved, and that there was not among them any one case sufficiently pronounced to warrant an order for its destruction. Doubts began to arise as to whether the disease was actually dourine or some other condition. Many examinations of blood and other body fluids obtained from infected animals were made in the field, and specimens were sent to various laboratories, but no trace of the presence of the parasites, or any definite information as to the nature of the disease, was revealed. RUTHERFORD drew attention to the fact that dourine, an indigenous disease in Asia and Africa, had become more irregular in its course and manifestations in Europe and America, and had probably become still further modified under the peculiar climatic conditions of the North-West Provinces of Canada. It was decided not to adopt immediately a policy of slaughter, but to retain the suspected animals during a further period in quarantine until more satisfactory evidence was

obtainable, and also in order to acquire as much information as possible regarding the behaviour of the disease in Canada.

In May 1905 the animals were again examined by RUTHERFORD and other veterinary officers. In some animals the disease was found to have progressed, while in others there was but little change from the conditions noted on previous occasions. One hundred and sixteen horses were destroyed and a considerable number were retained for further observation. Special officers were detailed to deal with the disease and were authorized to order the slaughter of any well-defined cases that came under their notice. In September 1905 it was decided to slaughter all the animals at the Quarantine Station with the exception of a few that had been under observation for more than twelve months and appeared to be healthy. It was then arranged to utilize the Quarantine Station for experimental work in connection with dourine, with HADWEN in charge, and a number of condemned animals were placed at his disposal. Three infected animals were sent to the Biological Laboratory, Ottawa, for study. Investigations were continued in the field and in the laboratories in the winter of 1905 and in the following summer. The disease was found to exist in various parts of Southern Alberta, and by the end of October 1906, 412 animals had been destroyed.

At the Lethbridge Quarantine Station breeding experiments were conducted in order to find out whether apparently recovered mares would bear healthy foals or remain sterile. Diseased and healthy stallions were employed. Several slightly affected mares were spayed, as it was hoped that such cases could be spared destruction and usefully employed for working purposes only. Search for the trypanosome was kept up continuously by microscopic examination and inoculation of dogs and other laboratory animals with blood and material obtained from diseased tissues, with invariably negative results. At Ottawa, HIGGINS and WATSON made a cytological study of the blood of dourine horses for purposes of comparison with normal horses and horses suffering from certain diseases. It was found that the leucocyte formula in dourine presented certain peculiarities and was of some diagnostic value. A pathogenic trypanosome, *T. gambiense*, was maintained and studied in a series of laboratory animals, mainly with the object of acquiring a knowledge of the habits and characteristics of such organisms. In October 1906 WATSON undertook the investigation of dourine and became stationed at Lethbridge. In November and December of this year he discovered trypanosomes in the blood of native "cotton-tail" rabbits and in a species of northern deer-mouse caught on the Quarantine grounds at Lethbridge. This finding represented the first record of trypanosomes in mammalian blood in Canada.

T. equiperdum was actually discovered by Watson in February 1907 in an affected mare. The reproduction of the disease by inoculation of these parasites into healthy horses and the recovery of the parasites from the typical lesions produced removed all doubt as to whether the dourine of America was a trypanosome disease or not, and the identity of the condition with the dourine of Asia and Africa and of European countries was clearly established.

However, in Africa and Asia, where the disease exists in its most severe form, no great difficulty seems to have been encountered in detecting the parasite or in diagnosing the disease by its clinical

manifestations. In Europe, on the contrary, search for the trypanosome was for many years unsuccessful. The course of the disease was found to be irregular and uncertain, and diagnosis as a rule had to be based on clinical symptoms, which as often as not were too vague and elusive to permit of satisfactory conclusions.

In America it became evident that the disease occurred in a still more insidious form, and that frequently no characteristic symptom or premonitory sign was presented in the early stages, which might become prolonged over very long periods. Moreover, the condition appeared to be far removed from being invariably a fatal disease; many infected mares retained or recovered apparent good health, although they were suspected of being capable of transmitting the disease to the covering stallion. The better bred, and especially the pure-bred imported, animals of high commercial value were usually the most severely affected and the first to succumb. Prairie-bred animals of the native pony and broncho types were best able to resist or tolerate the infection and thus become carriers; in the absence of any reliable means of diagnosing these cases they constituted a frequent and dangerous source of infection, for at this time large numbers of horses lived and bred on the open ranges, where natural conditions all favoured the spread of the disease. The prospect of eradicating the disease therefore, in view of the apparently insurmountable difficulties in diagnosis, did not seem encouraging.

During the next five years 1907–12 cases of dourine were discovered in a number of breeding districts in the Provinces of Alberta and Saskatchewan, by GALLIVAN and HAWKE. When an animal was found affected the fullest possible history of the case was secured, all animals which had been in contact by breeding were traced, and sick animals were placed in quarantine for an indefinite period, and they were not allowed to be bred from, sold, or removed, without special licence. Periodical examinations were made by the inspectors in charge, and as soon as a clear case of the disease had developed the animal was destroyed. It happened quite frequently, however, that no definite symptoms could be seen until the disease had run its course for nearly two years, and consequently horse breeding among such groups of animals, often numbering several hundred, had to be prohibited for two and sometimes three years in succession. Even then it was not always certain that some latent case had not been detected, and subsequent evidence demonstrated that in large outbreaks of dourine, especially among prairie-bred animals, such carriers almost certainly do remain and can only be detected by specific means of diagnosis.

Although no better measures of control could be devised in the circumstances, the prolonged quarantine for observation purposes, the periodic examination by veterinary inspectors, and the maintenance of large breeding establishments or herds of breeding mares which could not be used for breeding purposes, proved costly, onerous, and unsatisfactory. A large amount of research work was therefore accomplished during this period. Several strains of the trypanosome were in the meantime obtained from different outbreaks. Parallel series of experiments were made with the different strains in a close study of the pathogenicity, life-history, and variations in the virulence of *T. equiperdum*. The strains were maintained in horses, the evolution of the disease in its various phases was followed from year to year, and many observations and experiments were made upon the survivors. Mares which had spontaneously recovered, some from a

natural and others from an experimental infection, were successfully bred from and raised healthy foals year after year. It was found that these mares resisted reinfection and that the serum of such animals possessed immunising properties. The experimental treatment of dourine was investigated both from a preventive and curative point of view. Immunising sera and special drugs recommended in other trypanosome diseases—for example, atoxyl and arsenophenylglycin—were employed and reported upon. The chief object of the researches, however, was to determine a precise method of diagnosis, and thus the serum of affected animals was subjected to continuous study. Serum reactions and serum methods of diagnosis were worked out, and included a serum-globulin test, a trypanosome agglutination test, and a precipitation test. Of these the agglutination test was the most satisfactory, but did not meet all requirements. Watson spent the winter of 1911 and 1912 in studying trypanosome diseases in European laboratories. A German strain of dourine and an African strain were obtained from the Imperial Health Institute, Berlin, and brought to Canada for comparative work.

In 1912 considerable progress was made in serum diagnosis by adopting the complement fixation (or deviation) test. After several modifications and improvements in technique were made this test was found to provide a specific, precise, and uniform method of testing. As a means of diagnosis it answered all requirements, and came into general use in 1913 (for description of this test see this *Bulletin*, 1915, Vol. 3, No. 4, p. 118). Towards the end of that year a recurrence of the disease was reported in the southern districts of Alberta. Field investigations showed it to be very widespread, and to cover the old centres of infection of the first known outbreaks that had occurred 6–8 years previously. On one company's ranch 2,718 horses were involved, including a number of imported stallions and mares. Blood was collected from every animal and sent to the laboratory. As a result of the first test over 400 animals were declared infected. Some scepticism was at first evinced by the owners, inasmuch as animals that were apparently in good health were condemned as a result of a positive serum reaction. However, when many of these animals commenced to show symptoms and several died all opposition vanished, and the owners became quite willing to have their animals slaughtered and compensated for, and co-operated readily in stamping out the disease.

The complement test has since been employed wherever the disease has made an appearance in the country. It is stated to have proved of inestimable value as the main factor in the diagnosis and suppression of the disease, enabling an early and definite decision to be made. It is now quite sufficient to apply the test and re-test after a short interval in order to eliminate any doubtful reactors.

It was fortunate that this test was available when a widespread recurrence of the disease occurred in 1913–16. During this period every effort was made to cover the whole field of the disease, and it was then that the heaviest toll was paid in slaughter and compensation. The large Indian reservations situated within the infected area of Southern Alberta had been for a long time suspected of harbouring dourine. It was rarely possible to detect a case among the native ponies, but cases were frequently found among the better-bred animals of the neighbouring ranches, which from time to time strayed on to the Indian ranches. A serum test of these Indian horses indicated

many cases of hidden affection and of dourine carriers. This was not surprising, as the constantly intermingling herds, the Indian's habit of letting young stallions grow uncastrated until they had reached the age of three or four years, and promiscuous breeding, had given every facility for spreading the infection. In order to stamp out this last-remaining source of infection the droves were collected together and tested repeatedly, at intervals of six months to one year, and animals that gave a reaction to the test were destroyed. In connection with the serum diagnosis of dourine over 40,000 laboratory tests were made during the period 1911–20. From the time the disease first came under departmental action up to the date of writing (1904–20) 1,933 horses had been destroyed (1904–5, 292; 1905–6, 120; 1906–7, 167; 1907–8, 49; 1908–9, 28; 1909–10, 37; 1910–11, 40; 1911–12, 18; 1912–13, 18; 1913–14, 471; 1914–15, 394; 1915–16, 228; 1916–17, 48; 1917–18, 16; 1918–19, 5; 1919–20, 2).

Watson declares that in 1920 dourine appeared to have been totally suppressed in Canada. Moreover, if further outbreaks should occur, or the disease be reintroduced, it would never be allowed the opportunity of gaining much headway now that there are means at hand of detecting it, either in its initial or active stages, or in its latent or hidden forms. The disease can thus be dealt with promptly and effectively.

Finally, the testing of all stallions imported into Canada, and stallions that are travelled through the country for breeding purposes, would prevent the reintroduction of the disease and afford an adequate protection to the horse industry.

Watson closes his account of the disease with a series of excellent figures depicting the symptomatology and lesions and the causal organism.

STIRLING (R. F.). **Existence of *Trypanosoma dimorphon* in Central Provinces, India.**—*Vet. Rec.* 1921. Jan. 22. Vol. 1. (New Series.) No. 4. p. 71.

This short note is of particular importance, inasmuch as it may prove to be a record of the first described case of *T. congolense* infection in India. In June 1920 a bullock died under conditions which suggested trypanosomiasis, and blood smears were examined microscopically. Trypanosomes were found in large numbers, and they differed morphologically very considerably from *T. evansi*. They appeared to the author to resemble organisms of the *dimorphon* (or *congolense-pecorum*) group, and a smear was sent to the Veterinary Research Laboratory of the Union of South Africa in order to obtain confirmation of this point. The Acting-Director reported that numerous trypanosomes were found belonging to the same group as *T. dimorphon*. The parasites varied from 11 to 18μ in length, average 14·5—measurements agreeing very closely with those attributed to *T. nanum*.

VAN SACEGHEM (R.). **La Trypanosomiase du Ruanda.** [Trypanosomiasis in Ruanda (Belgian Congo).]—*C. R. Soc. Biol.* 1921. Feb. 5. Vol. 84. No. 5. pp. 283–286.

A serious outbreak of trypanosomiasis is raging at the present time among the large herds of cattle in the Kissengnie District of the Ruanda Province, and this outbreak furnishes still another

example of transmissibility of trypanosomiasis in the absence of tsetse fly. The altitude of this region everywhere exceeds 1,400 metres and tsetse nowhere exists. The disease appears to be of quite recent introduction, and, in fact, there is evidence that it was introduced by mules belonging to the Military Forces during the period of the war, and the disease became propagated thereby from herd to herd throughout the whole country.

When examined in the fresh state the trypanosomes are stated to exhibit polymorphism, show no free flagellum, and are actively motile, although they show no tendency to pass out of the field of the microscope. In stained smears made from the blood of naturally infected cattle they measure from 9 to 16μ long by 1·5 to 2μ broad, although sometimes they may reach 3μ when the undulating membrane is also included. The posterior extremity is rounded, the cytoplasm is generally homogeneous, but sometimes a few chromatinic granules are found in it. The centrosome is well marked, the undulating membrane is well developed, but is not often folded. The name *Trypanosoma ruandae* is provisionally allotted to the organism although it is admitted that further study may prove that it is quite indistinguishable from *T. congolense* (*pecorum-dimorphon*), with which it is morphologically very similar.

The trypanosome is pathogenic for cattle, sheep, guinea-pigs, and also for the equidae. Cattle affected clinically with the disease show all the signs of a progressive anaemia, enlargement of the lymphatic glands, and often a swelling of the eyelids, with a serous discharge from the conjunctiva. The naturally occurring disease was encountered only among cattle. There are very few equidae in the district, and thus it was not possible to ascertain whether the trypanosome was pathogenic for these animals. It was found possible to infect a native sheep experimentally, and trypanosomes appeared on the seventh day after injection of virulent blood. A guinea-pig was easily infected and showed trypanosomes on the eighth day. Attempts at cultivation in simplified Novy medium gave negative results, although the trypanosomes could be kept alive for 90 hours at 23° C. in this medium, and when examined they were found to have become agglutinated in masses.

There is good reason for believing that the vectors of the parasite are Stomoxys, which are very prevalent in the district at all seasons. It was quite easy to ascertain the presence of live trypanosomes in the intestines of this fly after it had been taken from animals infected with the disease, but on the following day the trypanosomes were found to have disappeared from this situation. The presence of living trypanosomes in the intestine of a fly after a meal on an infected animal proved that the salivary secretion of the fly is not injurious towards the trypanosomes, but, nevertheless, the organisms could not be found in the proboscis of the fly after persistent search.

In 1915, Van Saceghem recommended intra-muscular injections of tartar emetic for the treatment of trypanosomiasis in animals [see this *Bulletin*, 1916, Vol. 5, No. 1, p. 21]. The method at present adopted by him has been slightly modified. A solution of 4 per cent. tartar emetic is made in distilled water, and to this is added 4 per cent. of chemically pure sodium chloride. The addition of common salt is claimed to obviate the formation of the marked albuminous precipitate which becomes formed when a strong solution of tartar emetic is added to a serous fluid, and the irritant and necrosing

action of the substance is thereby diminished. A small incision is made in the skin prior to the insertion of the needle. This form of treatment is stated to have given immediate good results and no further deaths occurred. Five intra-muscular injections are given at five-day intervals; the treatment is then suspended for 15 days and a microscopic examination made of the blood.

SERGENT (Edm. & Ét.) & FOLEY (H.). **Essais de traitement du debab, Trypanosomiase des dromadaires. I. Afridol—II. Trypanobleu—III. Émétique et Atoxyl.** [Experiments in the Treatment of the Trypanosomiasis of Dromedaries known as Debab. I. Afridol.—II. Trypanblue.—III. Tartar Emetic and Atoxyl.]—*Ann. Inst. Pasteur.* 1921. Mar. Vol. 35. No. 3. pp. 204–206.

—— DONATIEN (A.) & LHÉRITIER (A.). **IV. Étude de l'action de l'émétique.** [A Study of the Action of Tartar Emetic.]—*Ibid.* pp. 207–211.

I. *Afridol Cl.*—A benzidine dye recommended by NICOLLE (M.) and MESNIL (F.) (O. dichlorobenzidine + Acid H), called in short Cl. This drug was injected into a female that had been infected experimentally three weeks previously. First dose 3 gm., second dose 4 gm. (15 days later), third dose 3 gm. (one month later), fourth dose 3 gm. (15 days later), fifth dose 2 gm. (one month later). Total 15 gm. in four months, subcutaneously. The trypanosomes did not disappear for long after the injections, but the general condition of the animal became quickly re-established. At the end of four months, from the clinical aspect, the recovery was perfect. After two to three years the blood ceased to be infective, and the animal became resistant to repeated massive infection with infective material.

A second dromedary infected experimentally was treated after the disease had been in progress one month, and trypanosomes were numerous. The dose amounted to 14·3 gm., given in five injections covering a period of five months. No effect was produced upon the number of trypanosomes or upon the general condition, and the animal died two months after the treatment had ceased, with trypanosomes in its blood.

II. *Trypanblue.*—Recommended by NICOLLE (M.) and MESNIL (F.) (O. tolidine + Acid H), called A in short.

A naturally-infected dromedary was administered 4 gm. per day three times in succession, with two-day intervals, but the trypanosomes did not disappear from the blood for more than four days. A second naturally-infected dromedary was first treated with three doses of 4 gm. each, given at two-day intervals, but the trypanosomes did not disappear for more than three days. A second attempt was made six weeks later with the same dosage, but again the organisms did not disappear for more than a few days. The animal died the same month, after having continuously shown numerous parasites in its blood.

A dromedary weighing about 350 kilogrammes was infected experimentally, and 2½ months later 7 gm. of trypanblue were injected. This dose proved toxic, the animal dying within 24 hours.

III. *Tartar Emetic and Atoxyl.*—A dromedary was infected experimentally, and numerous trypanosomes were frequently seen during the

ensuing five weeks, after which a mixed form of treatment was commenced; for three weeks 2 gm. of tartar emetic were injected intravenously each week, and three days afterwards 3 gm. of atoxyl were injected subcutaneously. The trypanosomes disappeared after the first injection. The dromedary made a clinical recovery, but it had to be sold after three months on account of the war.

A second dromedary was treated in the same manner as the preceding one, and subsequently made identical progress. These two dromedaries lived under natural conditions on the Sahara grass lands, and they were examined twice a week.

The authors conclude that with the doses employed Afridol Cl. produced recovery in one out of two cases, trypanblue proved a failure, whereas the combination tartar emetic and atoxyl appeared to be efficacious.

IV. *A study of the action of tartar emetic.*—In view of the above good results obtained in 1914 after the use of tartar emetic in debab, systematic experiments with the drug were undertaken. First of all the tartar emetic was examined as to its purity and especially as to its freedom from arsenic. It was employed in treatment dissolved in lukewarm distilled water 1 part in 200, and injected slowly intrajugularly—an operation which is easily performed in the dromedary.

(*a*) Action of a single dose.—Preliminary experiments were made on seven dromedaries. It was found that doses above 1·5 gm. were capable of killing a dromedary 300 kilogrammes in weight in less than 24 hours; 1·5 gm. and smaller doses were well tolerated; 0·5 gm. was not sufficiently active against trypanosomes; 1 gm. caused the trypanosomes to disappear from the blood, and the temperature became lowered, for eight days; while 1·5 gm. produced this effect for 10 days. It was therefore concluded that the dose that should be adopted was 1 gm.

(*b*) Action of repeated doses.—Since the trypanosomes reappeared in eight days on an average after the injection of 1 gm. of the drug, the second injection should be performed eight days after the first one. A series of four injections at weekly intervals therefore seemed indicated, and the animal was then to be allowed to rest. In the event of the trypanosomes reappearing in the peripheral blood this plan of treatment should be repeated.

The first investigation carried out on these lines was performed on nine dromedaries infected experimentaily in the laboratory. The blood was examined and the temperature taken daily. After an acute infection had been manifested for one or two months, with fever and very frequent appearance of trypanosomes in the blood (15 days out of 30 on an average), six of these dromedaries were taken and given the first series of four injections according to the above plan; the three other dromedaries were kept back as controls.

Of the controls, one showed trypanosomes after 18 months, another after 20 months, while the third died of trypanosomiasis in 15 months. In the case of the treated dromedaries the medication proved successful in four and unsuccessful in two cases after 20 months' observation. The four cases represented clinical recoveries, as evidenced by complete disappearance of trypanosomes from the blood when examined microscopically. One dromedary recovered after four series (*i.e.*, in nine months with 17 gm. emetic); a second after

five series (*i.e.*, nine months with 20 gm.); a third after six series (*i.e.*, in 10 months with 24 gm.), and the fourth after seven series of injections (*i.e.*, in 11 months with 28 gm.). Success was therefore claimed to have been obtained by the intravenous injection of tartar emetic amounting on an average to 22 gm. (in five series), covering a period of 10 months. An average dose of 2·2 gm. per month repeated during 10 months is therefore not toxic and may prove efficacious in treatment.

In the two unsuccessful cases, trypanosomes persisted in the blood. One of these cases was given 10 series of treatment (39 gm.), covering a period of 12 months. Trypanosomes reappeared 22 days after the last injection and persisted, as in the case of the controls, up to the time of death, which took place during the fourteenth month and was partly attributable to tartar emetic poisoning. The second failure occurred likewise after 10 series covering 12 months (38 gm.). The trypanosomes reappeared 20 days after the last injection, and subsequently were manifested as in the controls. A dose of 3·2 gm. per month repeated for 12 months is therefore stated to be toxic and inefficacious.

A point worthy of notice is that in the case of the four successful attempts the treatment was commenced somewhat later during the course of the infection than in the two cases in which the drug proved of no value. It is quite feasible to suppose that broods of trypanosomes resistant towards these drugs are created when the treatment is applied early.

The most striking symptom exhibited by females in the course of this disease is the constant occurrence of abortion during the acute phase of the infection, while the most noticeable sign of recovery in females treated with tartar emetic is the fact that pregnancy is accomplished normally. Three pregnant females infected experimentally in 1919 each gave birth to a dead young dromedary at full term, while a fourth animal affected with the chronic form of the natural disease gave birth to offspring which succumbed on the fourth day. However, in 1920, two of the female camels that had been successfully treated in the manner described above gave birth to quite healthy young.

The authors conclude that tartar emetic possesses great advantages when used in treatment on account of its low price and the ease with which it can be employed, viz., by intravenous injection, in the dromedary. But it has to be borne in mind that subtoxic doses sometimes have no action upon the trypanosome. There is thus room for investigation on combinations of tartar emetic with some other drug.

HOARE (Cecil A.). **Some Observations and Experiments on Insect Flagellates, with Special Reference to Artificial Infection of Vertebrates.**—*Parasitology*. 1921. Mar. Vol. 13. No. 1. pp. 67–85.

The first part of this work deals with the sheep ked flagellate (*Crithidia melophagia*), and its relation to the sheep trypanosome. A considerable amount of fairly exhaustive work has already been done on this subject since WOODCOCK, in 1910, discovered the natural occurrence of the trypanosome in the blood of British sheep, and BEHN confirmed these findings in 1911 and 1912 in Germany. The ked flagellate was studied in detail by SWINGLE in 1909 and PORTER in

1910, who concluded that it was a specific insect parasite, and that it was transmitted through the keds hereditarily, so that a second host, viz., the sheep, did not seem to be necessary. A large number of attempts at transmitting the flagellate to the sheep resulted negatively in SWINGLE's hands (1911). The presence of flagellates in young keds was therefore attributed to hereditary transmission (FLU, SWINGLE, PORTER). It had been shown that the number of trypanosomes in sheep's blood was, at all events, very scanty, and in most cases escaped detection by microscopic examination. CRAWLEY (1909 and 1912), however, showed that it was possible to cultivate trypanosomes from the blood of cattle when they could not be detected by ordinary methods, and this observation has been confirmed by many authors. Lately some very careful work has been done on this subject by NÖLLER (1917, 1919, 1920) in Germany, and by using special culture media and methods this author succeeded not only in cultivating trypanosomes from the sheep's blood, but also in bringing about the transition from the crithidial forms to trypanosomes in vitro. He thus appeared to have established the identity of the two forms beyond doubt, and named the trypanosome *Trypanosoma melophagium*, Flu 1908 (see this *Bulletin*, 1920, Vol. 7, No. 3, p. 135).

A few attempts were made by Hoare to confirm NÖLLER's work, but he did not succeed in cultivating trypanosomes from the blood of any of his four sheep, although they were infested with keds containing flagellates.

The authors who claim that the ked flagellates are transmitted hereditarily depict forms penetrating into the ova and thence into the developing embryo, but the forms described by the several authors would appear on examination to have nothing in common with each other. A number of ova and pupae were examined by Hoare, but he failed to find any forms which could be interpreted as stages of a flagellate organism, and the structures observed by PORTER were in all probability spermatozoa that had found their way into the ovaries. These authors, moreover, failed to find any traces of flagellates in the larvae or newly-hatched keds. It is only after prolonged feeding on sheep's blood that these organisms make their appearance in the gut of the young keds. It would, therefore, be natural to assume that the infection was obtained from the sheep's blood, but the above authors suppose that the organisms are present in what they term a cryptic stage in the larvae and newly-hatched keds, and become stimulated to final development by ingestion of the sheep's blood. Hoare made some attempts to infect mice artificially with the ked flagellates, and further extended his work so as to include experiments on artificial infection of different vertebrates with various insect flagellates. [A number of works upon this subject have been summarized recently in this *Bulletin*, notably those of LAVERAN and his collaborators and FANTHAM and PORTER.]

LAVERAN (1917), summarizing these researches, states that they firmly establish an affinity between Herpetomonas (and Crithidia) on the one hand and Leishmania on the other, an affinity which from the phylogenetic point of view is well recognised. FANTHAM even maintains they furnish proof that leishmaniases are arthropod-borne herpetomoniases, and that these maladies have evolved mainly from insect flagellates. Nevertheless, similar experiments repeated by other investigators produced negative results; thus CHATTON (1919) and NÖLLER (1920) repeated some of LAVERAN and FRANCHINI's (1919)

experiments with the dog-flea flagellate, but failed to find any trace of infection. Similar experiments were made by WENYON (1914) with the same flagellate, also with negative results, and this author also failed to produce any infection in rats inoculated with the flagellates of *Tabanus socius*. The question with regard to the pathogenicity of flagellates from insects which are not naturally associated with any vertebrate is of still more complex character.

Hoare describes experiments in which flagellates from the water scorpion, bluebottle, and sheep ked were inoculated into mice, sticklebacks, newts, and frogs. In the case of the mouse experiments no trace of flagellate infection was found, either by repeated blood examination or by blood culture. The experiments with sticklebacks fed with the water-scorpion flagellates showed that these organisms were merely digested like any other food. Likewise no trace of infection could be seen after inoculating the fish with the flagellates. Experiments with frogs also proved negative.

In the course of these experiments it was found that the flagellates could resist the action of digestive juices and remain alive in the intestine of fish for five hours, and in some cases for 18 hours. When injected subcutaneously or intraperitoneally into fish, they might be found alive in the peritoneal fluid for four days. Contents of the gut of the sheep ked, diluted with normal saline, were kept at room temperature and at 30°C. In the portion that was placed at 30°C. the flagellates lived only one day, but those kept at room temperature lived seven days. No multiplication was observed, and the flagellates gradually lost their motility. The flagellates from the water scorpion could be kept alive for five days at room temperature in saline and in broth.

The author concludes that the facts available at present do not permit one to assert that the natural herpetomonads in insects, especially in those not associated with vertebrates, may become pathogenic when introduced into the latter animals.

BRUCE (E. A.). **Bovine Coccidiosis in British Columbia, with a Description of the Parasite,** *Eimeria canadensis* **Sp. n.**—*Jl. American Vet. Med. Assoc.* 1921. Mar. Vol. 58. (New Series. Vol. 11.) No. 6. pp. 638–662. With 3 plates comprising 53 figs.

In America bovine coccidiosis has hitherto only been described as occurring in the States of Washington, SCHULTZ (1915); New Jersey, SMITH and GRAYBILL (1917); Pennsylvania, LENTZ (1918); and New York, WAY and HAGAN (1920).

None of these authors, however, except SMITH and GRAYBILL, gave an account of the coccidium seen in their cases, but from the description given by these two authors it would appear that all cases of coccidiosis are not due to one type of organism (see this *Bulletin*, 1918, Vol. 6, No. 3, p. 141).

Four outbreaks of the disease are on record in British Columbia—three in the Kamloops district and one near Clinton. No connection could be traced between these outbreaks, which occurred in different years and approximately 20 to 60 miles apart. The cases appeared in winter, and the winter climate of the dry belt of British Columbia is by no means mild. At the time of the first outbreak the temperature was about 30° below zero, and 40° below zero during the fourth. No explanation could be offered as to why the disease should be more prevalent during the winter season. The author gives a short account of the course of each outbreak.

The first outbreak, which occurred in February, 1917, involved a herd of 430 head of cattle, two-thirds of which were under three years of age; at least 100 were affected, and 28 died. Only two definitely known to be over three years of age were affected, and one of these succumbed. This outbreak, it is stated, is of particular interest, as it was complicated by a mycosis, which not only affected the intestinal tract, but in some cases became generalised and showed the presence of hyphae in the spleen. The mycelium was septate, and tended to grow in the intestine in the form of clubs about 29μ long by 3μ broad at the wider end. This fungus was so abundant that it was not for some time after the trouble had abated that coccidia were found to be implicated, inasmuch as a rectal examination was not made. It would appear that the coccidia were the primary cause of the trouble, as attempts to set up the mycosis by feeding on suspected hay gave negative results.

The second outbreak occurred in January, 1918, in a herd of 1,500 head, but the disease was, however, confined to three corrals, containing 575 animals, and of these 500 were under one year of age. It is estimated that at least 40 animals were affected, and the first case was noticed on January 3rd, after the animals had been on their winter feeding-grounds for four weeks. At least two bulls nearly three years of age were affected, but most of those affected were calves about 10 months old. Eleven deaths occurred, four of which were in yearlings and the remainder in younger animals. Treatment was commenced on January 14th and proved most effective, and only one calf died after that date. The infected ground was ploughed and the disease subsequently did not recur.

The third outbreak occurred in March, 1919, in a herd of 108 head of cattle, 57 of which were under one year of age. Eight calves from four to six months old were affected, and five of these died.

The fourth outbreak was reported towards the end of January, 1920, in a herd of 160 cattle but the owner had previously lost two animals, in December. The disease, however, was confined to a lot of 50 animals all of which were over one year of age, with the exception of a seven-months-old calf, which had been kept separate from the main lot. Sixteen out of these 50 animals became visibly affected, and six died, viz., one yearling, two 2-year-olds, two 3-year-olds, and one cow. This outbreak was of interest inasmuch as the disease was confined, with one exception, to older animals. The calves were kept about half a mile away from the older cattle. Treatment as recommended in the second outbreak was instituted, and shortly after it was commenced one more case was seen, but no more deaths occurred and after two weeks' treatment the animals appeared healthy.

The symptoms described do not appear to present any noteworthy differences from those recorded in outbreaks elsewhere, viz., diarrhoea with the presence of blood clots in the faeces, and in chronic cases emaciation and anaemia, severe straining, sometimes grinding of the teeth; fever usually absent or very slight. A prominent feature in these cases was that with perhaps one exception fits were exhibited in all fatal cases just before death. Death occurred in from 8 to 24 hours after these fits were first seen and the animals then died in convulsions. Fatal cases usually died in from two to five days after the first symptoms were noticed. These fits, which might be attributed to cerebral anaemia, occurred at varying intervals. One cow was noticed to suffer from

three fits while it was being driven a distance of 50 yards. It would seem that they were induced when the animal was disturbed; it appeared frightened, staggered, sometimes braced itself by resting its head on the ground with the forelegs widely spread, fell over, and frothed at the mouth. In a little more or less than a minute the animal got up and behaved as if nothing had happened. Only one animal was definitely known to have recovered after having shown one of these fits. Death sometimes occurred when the diarrhoea was abating.

The incubation period, that is, the period elapsing between infection and the first appearance of blood or oocysts in the faeces, was found out experimentally to be about 14 days.

Diagnosis essentially resolved itself into ascertaining the presence of the oocyst. One American author, however, has stated that the fertile encapsulated forms, that alone can infect pastures and cause disease in susceptible animals, are not formed in animals that perish, but in those that recover. This was not in accordance with Bruce's experience with cattle, as well as with rabbits and fowls, in British Columbia. A haemorrhagic diarrhoea usually following constipation, rapid emaciation, absence of high temperature, and convulsions, would suggest the disease, but a definite diagnosis is not possible without recourse to microscopic examination. In cases, where it was difficult to find the coccidia in the faeces the following method was used:—The faeces were diluted with an equal quantity of water, strained through a fine wire screen and then through several thicknesses of cheese cloth. If necessary this procedure was repeated a second time, the fluid obtained was then centrifuged for several minutes, excess poured off, and the residue examined. During the course of the work three different species of flagellates and an amoeba were seen. In one animal, a calf, two specimens of a Balantidium were noticed, measuring 126 by 89·5μ.

The post-mortem changes were similar to those described in other outbreaks, the most prominent lesions being in the rectum. The blood showed poikilocytosis and some polychromasia, but a polynuclear leucocytosis as reported by MAYER and CROCKER and by FANTHAM in birds was not seen. The leucocyte count in four affected cattle was as follows: total mononuclears 72·12, polynuclears 21·33, eosinophiles 6·41, mast cells 0·12. The parasite invariably destroyed its host cell completely but did not appear to have any deleterious effect upon neighbouring cells.

Treatment as recommended in various text-books could not be applied to an extensive outbreak or to range animals. It was therefore decided to try the following treatment:—Sulphate of iron 2 parts, sulphur 2 parts, salt 6 parts. Of this mixture 50 lb. was fed with 100 lbs. of linseed oil cake to 100 head of cattle per day. The mixture was placed in troughs to which the animals had free access. The results obtained are claimed to have been most gratifying. The treatment should be continued for two weeks. It is admitted that, owing to the tendency of the disease to spend itself many cases recovered spontaneously. However, there can be no doubt that if an animal can be helped over the acute stage its chance of recovery is enhanced.

Some of the oocysts in the faeces were kept under unsatisfactory conditions in the laboratory and found to be infective for 13 months.

FANTHAM has already shown that the oocysts of *Eimeria avium* are infective for two years after they have been passed. Sick animals should therefore be isolated, so that their faeces can be properly disposed of.

It is of interest that on one ranch the carcases of the dead cattle were fed to the pigs, which ate nearly everything but the bones, and therefore must have ingested a large number of oocysts. None of the pigs, however, showed any signs of disease. Horses, sheep and fowls kept on the same premises as infected cattle did not develop any symptoms, and guinea-pigs, rabbits, white rats and fowls were dosed with infective material, with negative results. The coccidium therefore appears to be specific for cattle, and experimentally it was proved that the disease could be transmitted to animals varying in age from one month old to one that was an aged cow. In the field animals ranging from four months old to one aged animal were found to suffer. The disease was most severe and death often resulted in younger animals. Three-year-old animals, however, were also found to succumb sometimes, and in one instance an aged cow died.

The author then describes some transmission experiments.

In view of the fact that this author describes under a new name the coccidium encountered in this disease, the description he gives of the parasite warrants careful notice.

Development of the Oocyst.

The oocyst varied in shape: spherical, elliptical and ovoid forms were seen, and rarely the ovoid cysts showed a slight flattening at the smaller end or were slightly concave. In adult animals about 45 per cent. were spherical, but in very young calves these forms were rare. The larger oocysts were always ovoid or elliptical. The smaller cysts apparently showed a tendency to become spherical in course of time, and in some faeces that had been kept for two years it was difficult to find other forms than spherical ones. All the cysts were circular on cross-section. The wall was double-contoured and varied in tint from colourless to a light mouldy brown. In the ovoid cyst the wall tended to diminish slightly in thickness towards the narrow pole. No evidence of a micropyle was seen. In the early stages of the disease the oocyst appeared to be larger, and in very young calves they were usually elliptical in shape. The measurements were (about 250 examined) from 11·6 to 43·1 μ in length, and from 11·6 to 27·8 μ in width. In animals over four months old (210 cysts examined) the measurements were, on an average, 17·4 by 15 μ, and cysts exceeding 20·7 by 17·6 μ were very scarce. In calves about six weeks of age it was not uncommon to find oocysts 33 by 24 μ.

The forms usually seen in fresh faeces were those in which the cytoplasm either completely filled the cyst, was beginning to contract, or had contracted into a circular mass. In the earlier stage the granules were finer than in the forms in which the cytoplasm had contracted. The granules were highly refractile, and occasionally they showed amoeboid movement. This phenomenon was observed to occur for over twenty minutes before the cell came to rest.

The nucleus was sometimes visible. The commonest form was that in which the cytoplasm had contracted into a circular mass, usually at the middle or towards the end of the cyst. It was composed of coarse, highly refractile granules, and the nucleus was sometimes visible in it.

In the next stage the granules separated, and the central mass divided up into four sporoblasts without a residual body, and each sporoblast secreted a homogeneous membrane, the sporocyst, in which it became enveloped. The contour of this membrane was in some cases bent at acute angles. The sporocysts became ellipsoidal in shape and circular on cross-section. At first they contained refractile granules, but then became homogeneous, and appeared to contain a number of vacuoles. Each sporocyst became pointed at one end, and a large vacuolated body appeared in the broad end, and the protoplasm then contained well-marked granules. The vacuolated body then moved towards the centre and divided; each half then moved towards the opposite pole.

The sporocyst now commenced to divide longitudinally to form the sporozoites. The single contoured membrane of the spore became thickened into a minute cap at the smaller pole (Stieda's plate), and two sporozoites were formed in the spore together with a residual body composed of refractile granules; this body usually lay between the sporozoites, but sometimes it was scattered; it was relatively larger in the smaller oocysts. The line separating the sporozoites tended to run diagonally across the spore, and this was more marked in the smaller cysts.

The sporozoites were broad at one end and tapered towards the other. The nucleus lay in or near the broad end, and the broad ends were placed at opposite poles of the spore; with their residual body the sporozoites completely filled the spore. The sporocysts varied in length from 6·6 to 19·9μ, and in breadth from 4·5 to 8·3μ.

It was shown that the sporozoites, under favourable conditions, were capable of rapid development, for one heifer showed evidence of infection after it had been dosed with faeces three days previously. On one occasion an oocyst was found to contain fully developed spores in faeces that were not more than 24 hours old, and had probably been passed less than 12 hours. Sporoblast formation was seen in faeces 24 hours old, but it was rare. When kept in the laboratory and supplied with moisture, complete development did not occur in less than eight days, and was delayed for weeks or months if too much or too little moisture was supplied. Some centrifuged faeces kept in a centrifuge tube, and supplied with a little moisture at very irregular intervals, showed after 13 months some oocysts that were still infective, some that had never developed, and a number that contained gas bubbles indicating degeneration.

Endogenous Development.

The description given of the development of the parasite in the tissues is of much interest, for there has been need for work upon this subject as it has been commonly taken for granted that the development of the cattle coccidium was probably identical with that of the rabbit parasite. The author illustrates his description with a number of good figures.

The sporozoites varied undoubtedly a great deal in size, but only two were seen in sections, and they measured approximately 10·7 by 2·4μ. They differed from the very similar merozoites in respect of their nucleus, which did not show a karyosome, was comparatively

a little smaller, and was eccentrically located. Uninuclear schizonts were scarce in sections, and those seen measured 5·8 to 8·3μ by 4·9 to 7·4μ. They were rounded or elliptical in outline, their cytoplasm was alveolar, and the nucleus was usually eccentrically placed, relatively large, and contained a karyosome. The nucleus of the trophozoite then divided, and the number of nuclei produced then varied greatly in number. Forms containing as few as six were seen, up to those in which the number could not be counted. At first the nuclei were minute specks, but soon a clear area was seen around them, which gradually grew until it elongated to form the body of the future merozoite. At the same time the nucleus increased slightly in size, and, when the merozoites were well advanced, showed a well-marked karyosome. Schizonts were seen measuring from 8·3 by 8·3 to 61·4 by 49·8μ.

On one occasion a minute yellowish spot in the small intestine was placed under a cover slip and examined, and slight pressure was exerted upon it. This proved to be a schizont, the author states, containing merozoites that were evidently fully developed, as evidenced by a slow but distinct movement of their posterior end, and which were arranged into approximately 30 "bunches," each "bunch" being composed of merozoites, which radiated in all directions from a common centre with their posterior end (that is, the end further from the nucleus) towards the outside. This mass measured approximately 282 by 207μ. One or two other spots of apparently similar nature were seen in this intestine. [We suspect that this structure is identical with that first described in the small intestine of cattle by THEOBALD SMITH in 1893, and by MAROTEL, at Lyons, in 1907. The significance of these bodies is commented upon by RAILLIET (*Rec. Méd. Vét.*, 1919, Jan. 15, Feb. 15, Vol. 95, Nos. 1 & 3, p. 8), and he considers them to be analogous with the similar forms first encountered by MOUSSU and MAROTEL (1901-2) in the small intestine of sheep affected with coccidiosis. These bodies were subjected to a careful study by CHATTON (1910) and named by him *Gastrocystis gilruthi*; the structure was found also to be present in the abomasum of nearly all sheep and goats slaughtered at Paris, and its morphological details presented considerable affinities with the Sarcosporidia.—ED.] While in this unique schizont the merozoites were arranged in stellate form, in the schizont usually found they did not seem to follow any definite form, but resembled somewhat a lot of fish thrown into a basket. The schizont was circular or elliptical in outline, sometimes comparatively regular, and sometimes comparatively irregular. There was no cell membrane. The merozoites were about 10μ long by 2·9μ broad, but were subject to slight variation. Their cytoplasm was finely granular, and their nucleus contained a well-marked karyosome and was located towards the broader end.

Uninuclear microgametocytes were scarce in sections, elliptical in shape, 3·3 by 4·9μ, and their cytoplasm was not alveolar. Their nucleus was eccentrically placed and consisted of a karyosome surrounded by a halo which was sometimes not very distinct. The nucleus then broke up into minute granules and formed a fine chromidial network and, later, a number of minute spots, usually aggregated in masses, sometimes evenly distributed and at other times placed at the periphery. Minute loops were then formed, each of which gradually became more open and showed a slight

thickening towards one end; the loop then disappeared and the microgametes became bow-shaped and showed a slight thickening towards their middle. These stained intensely with the basic aniline dyes and were arranged in the cell in three different ways, viz., around the periphery, in a well-marked band completely filling the cell, or in a reticular manner without any definite arrangement. When fully developed, the microgametocytes showed enormous variation in size—from 8·3 by 11·6μ up to forms so large as to fill the whole field of an oil immersion lens (116·2 by 132·8μ). The microgamete measured approximately 0·55 by 2·75μ. While it undoubtedly possessed flagella, these could not been seen.

The young microgametocyte could be distinguished from the uninuclear schizonts and microgametocytes by its rounder shape and its relatively large nucleus which was eccentrically placed and contained a karyosome. The smallest forms seen measured 3·3 by 3·3μ. At an early stage metachromatic granules were seen and the chromosomes became unravelled from the nuclear network (seen in a cell 8·3 by 6·6μ). The cell continued to grow and become loaded with chromatoid and plastinoid granules. The nucleus at this stage lost its rounded shape and contained a number of chromidial threads. The lighter staining plastinoid granules moved to the periphery and the chromatoid formed a more or less irregular circle around the nucleus. Owing to the deep staining of the chromatoid granules the nuclear changes were often obscured. The nucleus next showed a chromidial network surrounding the karyosome. Fertilisation took place, but this process was not actually observed. The nucleus then underwent several changes and became temporarily resolved into chromidia from which was formed, by concentration of the scattered granules, another complete nucleus. Shortly after fertilisation the cell began to show a thin membrane, apparently formed from the plastinoid granules. The wall appeared to form slowly. There was no evidence that the inner wall of the chitinoid membrane was formed by the chromatoid granules as pictured by FANTHAM in *Eimeria avium*.

The endogenous cycle of *Eimeria zurni* does not appear to have been worked out, and comparison of the coccidium described by BRUCE must therefore be based upon the characters of the oocyst. In ZUBLIN's description of *E. zurni* no residual body is stated to be left behind in the formation of the sporoblasts and there is no residual body in the spore; in the British Columbia species a residual body occurs in the spore. SMITH and GRAYBILL described two varieties of oocysts in the coccidiosis of young calves in New Jersey viz., one small and corresponding to *E. zurni*, and the other larger and corresponding to Bruce's parasite, except that his coccidium showed a much greater variation in size. These authors, however, were unable to distinguish any difference in the endogenous cycle. Evidence of active multiplication in cattle older than three months was not noted by SMITH and GRAYBILL, and in their calves the seat of the disease was the large intestine. In British Columbia animals of all ages were affected, and while the large intestine suffered most in adult animals, in calves of three months or so the small intestine was most infected. Bruce believes that the coccidium here described differs from any previously described coccidium, and proposes to call it *Eimeria canadensis*.

BALOZET (L.). **Fréquence des formes latentes de piroplasmose bovine au Maroc.** [The Frequency of Latent Forms of Bovine Piroplasmosis in Morocco.]—*Bull. Soc. Path. Exot.* 1920. Nov. 10. Vol. 13. No. 9. pp. 733–734. With 2 figs.

Piroplasmosis is a very common disease among cattle in the well-irrigated districts situated at the foot of the Middle Atlas mountains in Morocco; ticks are particularly numerous in the luxuriant vegetation of the district. The disease affects, on rare occasions, the cattle of the district in a mild form, but it is, on the other hand, common and often fatal among animals brought in from other districts, especially from the mountains. The breed of cattle that exhibited no disease symptom reveals piroplasms in about 40 per cent. of animals; the parasites are rare (one in every 5–10 fields), and are all rod, oval or ring-shaped or in the form of small points as described by VELU (1915); they thus resemble *Theileria parva, mutans,* or *annulata,* or the rod-shaped piroplasms described by SCHEIN in French Indo-China and in Algeria by SOULIÉ and ROIG.

In animals affected with acute piroplasmosis the author observed, associated with the preceding forms, the presence of bigeminate pear-shaped forms, which sometimes became very numerous, forming 20 per cent. of the total number of parasites. This association of the two forms of parasite in the acute type of disease has been recorded by SCHEIN in French Indo-China, and by others in Madras and Japan.

[It is difficult to identify exactly from the diagrams furnished by the author the type of piroplasm in the acute form of the disease. Some appear to be undoubtedly *P. bigeminum,* but at least one diagram recalls *P. divergens* (*bovis*), and it would appear that *P. bigeminum,* associated perhaps with *P. divergens,* is actually responsible for the morbid symptoms. The other piroplasms depicted in the blood of healthy cattle are undoubtedly *Gonderia* (*Theileria*) *mutans,* found widespread over the Continent of Africa.—ED.]

SERGENT (Edm.) & ESPÉRANDIEU (G.). **Études sur les piroplasmoses et les jaunisses en Algérie. VIII. A propos d'un accès suraigu de piroplasmose bovine à petites formes annulaires extrêmement nombreuses.** [Studies of the Piroplasmoses and Jaundices of Algeria. VIII. A Hyper-acute Attack of Bovine Piroplasmosis with Extremely Numerous Small Ring-Shaped Forms.]—*Bull. Soc. Path. Exot.* 1920. Dec. 8. Vol. 13. No. 10. pp. 779–783. With 2 text figs.

In this note the authors describe the case of a cross-bred native cow that had been affected with foot-and-mouth disease in May 1920 and became again severely affected with the disease in July. Local treatment was applied to the lesions and improvement seemed to have set in, but early in August the condition of the animal became again extremely serious. It showed depression, the horns were hot, the mucous membrane yellow and covered with petechiae. The buccal mucous membrane was extremely pale, the coat was rough; the animal was first affected with constipation, followed by abundant diarrhoea, which was, however, seen in all the cattle affected with foot-and-mouth disease. The cow was killed, and on post-mortem examination the blood was jaundiced, the spleen was enlarged and the spleen pulp friable. A yellow jelly-like material filled the mediastinum, the bone marrow of the tibia was semi-fluid, and small haemorrhagic areas were

strewn throughout it. The myocardium and the psoas muscles were macerated in appearance; the bladder contained a clear chocolate-coloured urine.

The peripheral blood examined at the time of slaughter showed an extraordinary number of parasites, and the majority of the corpuscles contained multiple parasites.

Out of 1,000 corpuscles 76 contained no parasite, 197 one parasite, 278 two parasites, 231 three parasites, 123 four, 55 five, 29 six, 9 seven, and 2 eight parasites; that is, 2,466 parasites in all. The size and shape of the invaded corpuscles were not changed. Scarcely one parasite in every 100 touched the margin of the corpuscle. Out of 2,000 parasites, about 1,700 were in the form of small round or oval rings, not pear-shaped and not exceeding 1μ in diameter, with an eccentric nucleus and a central vacuole. About 280 were in the form of short rods reaching up to 1μ in length, with a terminal nucleus which was always round and often contained a vacuole. About 20 forms resembled anaplasms.

With regard to the ring-shaped forms, a number (152) could be seen as very small chromatinic granules which could not be differentiated from anaplasms except by the presence of a thin blue ring attached to the red bezel. All grades of transition up to the largest rings, 1μ in diameter, with a round bezel, could be seen (505 forms). In numerous elements (944) the nucleus appeared stretched out, representing the first stage in binary division; this was seen in 92 forms and was of exactly the same type as that of Plasmodium in human blood, that is to say, it took the form of a ring broken through the bezel with a knob at each broken end. The nucleus was never centrally placed.

The rod-shaped forms likewise commenced as very small forms—a strand of cytoplasm attached to a chromatin granule. The nucleus always remained rounded, in the form of a granule, but the cytoplasm became elongated (140 elements), and then contained a vacuole (141 elements). In the vacuolated elements the cytoplasm became condensed at the opposite extremity of the nucleus. It was often only possible to distinguish the nucleus from this cytoplasmic granule by staining reactions.

Very rarely, atypical forms in the process of disintegration, with very sparse cytoplasm containing scattered chromatin granules, could be seen. The small anaplasma-like forms might be regarded as merozoites resulting from the fission of the ring-shaped forms with two nuclei. In the course of their development these anaplasms may give rise either to rings, or themselves develop until they undergo binary division, or, more rarely, to short rods, which perhaps also manage to give rise, in the course of a little slower development after the formation of a vacuole, to ring-shaped forms.

These parasites are reminiscent of *P. annulatum* of DSCHUNKOWSKY and LUHS, but *P. annulatum* is not a valid species, inasmuch as it comprises forms belonging to *Gonderia mutans* or to *Theileria parva* or even to forms of *P. bigeminum*. The name should therefore not be retained.

The following characters at once contra-indicate identity with *P. bigeminum* or *P. bovis*:—Complete absence of pear-shaped forms and of bigeminate forms; when two parasites are found contiguous it is obvious that their proximity is fortuitous; the diameter of the parasite is always very small and never exceeds 1μ.

Moreover, one cannot assign the parasite to the species *Gonderia mutans*, for rod-shaped forms are very rare, and none of them has a bacillary nucleus. There are no cross-shaped forms; the number of invaded corpuscles is enormous.

Likewise, the parasites cannot be assigned to *Theileria parva*, on account of their morphology, and especially on account of the symptomatology—blood-stained urine, jaundice.

The question arises as to whether they are merely very young forms of *P. bigeminum* or *P. bovis* which by very rapid binary division of the small forms lead to the death of the animal in a few hours, thus giving no time for the large forms to develop. This process would be comparable to that found in malignant malaria in man, for in this condition one sometimes sees during the pernicious attacks simply ring-shaped small forms, many of which are undergoing division.

The authors conclude that the condition described by them was in the nature of a pernicious attack due to very small ring-shaped forms of an undetermined species of piroplasm undergoing intense binary division and present to the extent of about 2·5 parasites per corpuscle.

VELU (H.). **La Piroplasmose bovine au Maroc et ses rapports avec les piroplasmoses circummediterranéennes.** [Bovine Piroplasmosis in Morocco and its Relationships with the Piroplasmosis of the Mediterranean Basin.]—*Bull. Soc. Path. Exot.* 1921. Feb. Vol. 14. No. 2. pp. 116–124.

The nature of the piroplasmosis found in cattle in countries bordering upon the Mediterranean Sea still remains a problem which requires much elucidation, and the symptoms manifested in the affections are often of a very divergent character. Velu therefore collates a number of observations made in Morocco during the last ten years, and compares them with those recorded by other authors.

The symptoms resemble those seen in East Coast fever and in the tropical piroplasmosis of the Transcaucasus region, as described by DSCHUNKOWSKY and LUHS in 1904. Clinically, Velu distinguishes three forms, viz., an acute, sub-acute, and chronic form.

In the acute form the period of incubation extends from 10 to 30 days, and the disease is first manifested by a sudden rise in temperature. Then for two or three days nothing is seen. Rumination stops, the appetite becomes capricious, the temperature remains high, the pulse and the respiration become accelerated, and the urine is almost always normal in appearance, and sometimes only has a reddish tint. The saliva flows away in stringy filaments, and there is an abundant serous discharge from the eyes. The pupils become swollen, and the superficial lymphatic glands enlarged. The visible mucous membranes are congested and show numerous petechiae. Not infrequently cerebral symptoms, muscular tremblings, and grinding of the teeth are seen, diarrhoea is common, and finally becomes blood-stained. Towards the last stage of the disease the animals lie down in a state of great depression. In four to six days the temperature falls, and the animal succumbs. The blood is not changed in appearance.

The sub-acute form is more common, and lasts from eight to ten days. The symptoms are similar, but do not develop so quickly and are not intense. The urine always remains clear. A yellowish, sometimes greenish, discoloration of the mucous membranes is more characteristic

of this slowly developing form, which may sometimes last 15 to 20 days. If the animal survives the disease assumes a chronic form. The blood shows marked changes. It remains liquid and clots slowly. The serum is bile-coloured.

The chronic form is characterised by the temperature curve. The cachexia is ushered in by intermittent febrile attacks, lasting two to eight days, separated by afebrile periods. The condition ends in recovery, and the febrile attacks become gradually less and less marked. The symptoms are those usually associated with chronic piroplasmosis. The skin becomes thickened, "hide-bound," and the coat rough, the mucous membranes assume a jaundiced appearance, red-water is not seen, but the urine contains albumen and bile pigment. The animal wastes rapidly; the number of red corpuscles diminishes; sometimes the pulse becomes imperceptible; and, subcutaneous infiltration and oedematous swellings may be seen on various parts of the body, especially in the intermaxillary space.

The disease is particularly severe in imported animals. In Libya, CARPANO observed a case-rate of 100 per cent., and a death-rate of 90 per cent. in cattle imported from Serbia; these animals were particularly susceptible, and especially the young and female animals. Animals imported from Sardinia, Tunisia and Southern Italy appear to be less susceptible. Velu, in Morocco, made identical observations. As a general rule, imported cattle are particularly susceptible, and the first cases appear a month or two after disembarkment in Libya, Algeria and Morocco. These cases are always followed by several others, until nearly all the animals become affected; whilst native animals mingling with affected animals at the same time do not appear to suffer. In the majority of cases the disease passes unobserved in these animals, unless one takes the temperatures daily and makes blood examinations during the febrile periods. In Morocco the disease affects particularly young animals, and causes a high mortality. Recovery, if it takes place, is brought about very slowly, and convalescence always takes a long time. The disease appears generally in animals that have been travelled, although the fatigue involved in movement cannot be incriminated, for the first cases are sometimes observed after a considerable lapse of time—weeks or even months subsequently—and sometimes it appears after very short journeys. It is probable that there are local strains of parasites.

Lesions.—Post-mortem, one finds congestive lesions and small haemorrhagic points on the serous membranes, gelatinous infiltrations into the tissues, and blood-stained specks in the tissues. The lymphatic glands are enlarged and congested and infarcted on section, and a large quantity of liquid exudate flows from them. The spleen is enlarged in the acute and hyper-acute cases, but normal in the chronic cases. Neither the spleen pulp nor the lymphatic glands show multiplication forms of the piroplasms. The typical lesions of the disease are, however, according to CARPANO, the ulcerative lesions of the fourth stomach, which have been described by KOCH, and by DSCHUNKOWSKY and LUHS in the Transcaucasus. These lesions are also found in the colon and caecum. DUCLOUX, however, considered that they are due to *Linguatula serrata*, and Velu also maintains, from examinations made of them in Morocco, that they are not ascribable to piroplasmosis.

In the acute forms of the disease the blood is not altered macroscopically or microscopically. In the sub-acute forms the changes are very marked, the blood is more liquid, clots slowly, and the number of

parasites in the red corpuscles is high. In the chronic forms the blood is watery and the number of red corpuscles may diminish to three millions per cubic millimetre. There is a leucocytosis affecting the mononuclears and polynuclears (CARPANO). The parasites are generally small in number ; the number of corpuscles invaded has been reported to be 10 per cent. by MONTGOMERY, 30 per cent. by SERGENT and LHÉRITIER, and up to 55 per cent. by Velu and EYRAUD.

The different types of parasites encountered in the affected animals have been described by authors, but there is considerable lack of unanimity with regard to their nature. Morphologically, the parasites all present the characteristics of *Theileria annulata* and of *Theileria parva* or *mutans*. In the blood they assume the shape of very slender bacillary forms, with a mass of chromatin occupying about the middle of each rod, comma-shaped forms, with all the chromatin condensed at the larger extremity of the comma, ring-shaped, rounded and ovoid forms, or pear-shaped forms with the chromatin arranged in the horseshoe fashion at the larger extremity surrounding a clear central area. These forms differ from the characteristic pear-shaped elements of *P. bigeminum*, inasmuch as they are smaller—2–3μ in length at most—and they are not usually found in pairs. Amoeboid and dot-like forms are also seen. In the ring-shaped forms, as well as in the rod-shaped ones, the chromatin is surrounded by a protoplasmic zone.

According to KOCH the parasite closely resembles *T. parva*, and DUCLOUX maintained that the Tunisian parasite resembled *T. annulata*. LAVERAN stated that the parasite found by LESAGE and HELIOT did not resemble *P. bigeminum* or *T. parva*. SOULIÉ and ROIG claimed that the disease observed by them presented resemblances both to East Coast fever and the Transcaucasian disease, and the parasites to *T. mutans* and *annulata*. According to THEILER, who examined smears sent to him by PRICOLO (this *Bulletin* 1917, p. 230) the parasites cannot be differentiated from those found in the blood of animals affected with East Coast fever, and, in particular, the presence of KOCH'S bodies left no doubt but that the parasite was in reality *T. parva*. According to CARPANO the disease would appear to be caused by to *T. parva* and *T. annulata*, and *T. annulata* would seem to be more nearly related to *T. mutans* morphologically and pathogenetically than to *T. parva*. The parasite would appear to reveal itself either as a rounded or ring-shaped form, oval form, pear-shaped form, or whip-shaped amoeboid, granular or anaplasma-like form.

BRUMPT maintains that although *T. mutans* may be identical in appearance with *T. parva* in the peripheral blood it can be easily distinguished from it by the absence of the characteristic developmental schizogonous bodies of the latter species, by its relatively feeble pathogenicity, and by the difficulty in transmitting it to healthy animals (see preceding number of this *Bulletin*, p. 1).

In certain cases piroplasms cannot be encountered in the blood. SERGENT (Ed.) LHÉRITIER and BOQUET have described a certain number of cases presenting a typical clinical picture of acute or hyperacute piroplasmosis with complete or almost complete absence of piroplasms in the peripheral blood or blood of the internal organs. A diagnosis of piroplasmosis might have appeared justified in such cases on clinical grounds and on account of the fact that other contagious diseases were eliminated by laboratory examination. However, it would appear, according to SERGENT, LHÉRITIER and PASTEUR VALLERY-RADOT, that the affection is a separate and distinct

one, which they call "*la Fièvre bilieuse hémoglobinurique*" (haemoglobinuric biliary fever), and Velu claims to have encountered this condition several times in Morocco. The conditions which have to be differentiated from piroplasmosis are anthrax, haemorrhagic septicaemia, and rinderpest. Rinderpest may be easily confounded with the sub-acute form. Diagnosis may be made by microscopic examination of the circulating blood, and CARPANO recommends an exploratory puncture of the prescapular gland. Velu, however, did not on any occasion succeed in demonstrating KOCH'S bodies in cattle affected with piroplasmosis in Morocco.

Attempts at experimental inoculation have been made by a number of authors. DUCLOUX inoculated an ox with the pear-shaped forms, with negative result. SOULIÉ and ROIG infected six native cattle, which subsequently reacted but did not die. A cow belonging to a French breed succumbed on the second day after the inoculation and presented all the lesions of piroplasmosis, but no parasites were seen on microscopic examination. According to CARPANO inoculation of blood of affected animals into healthy cattle sets up a sudden rise of temperature, due apparently to the reaction of a toxin. The inoculated animals present the symptoms of a single infection due to *T. annulata*, and the parasites persist for a long time in the blood after clinical recovery as they do in the natural disease. The resistance of animals belonging to certain regions tends to prove that the disease exists not only on the African side of the Mediterranean Sea, but also in Sicily, Sardinia, and Southern Italy. BRUMPT inoculated three calves successfully with the blood of adult Tunisian cattle, but they, however, did not present subsequently any clinical symptoms.

CARPANO claims to have succeeded in obtaining a culture of the piroplasms by adding 9 cc. of defibrinated infected blood to 1 cc. of sterile water containing 7 per cent. sodium chloride and 7 per cent. sodium citrate, and placing the mixture in an incubator at 25°C. After ten days anaplasma-like forms were seen, which then became flagellated and resembled the forms seen in infected ticks. These were regarded as the sexually differentiated elements.

Experiments made by BRUMPT to determine the transmitting agent gave negative results. CARPANO claims that the vector is *Hyalomma aegyptium*; cattle harbour only the adult tick, while the larva and nymph live on wild animals. BRUMPT is of the opinion that it is necessary to study ticks living at various stages in their development on cattle in order to find out the transmitting agent, and he believes that *Rhipicephalus bursa*, and to a less extent *Rhipicephalus sanguineus*, must be suspected.

With regard to prophylaxis, CARPANO made some attempts at immunisation, which did not, however, give any noteworthy results. Trypan blue appears to have no curative property. Arrhenal gave, according to PIOT BEY, interesting results. Sodium cacodylate, administered in large doses intravenously, gave in Velu's hands most encouraging results.

SERGENT (Ed.). **Étude morphologique du** *Piroplasma* (*Gonderia*) *mutans* **du Boeuf.** [A Morphological Study of *P.* (*G.*) *m.* of the Ox.]—*Ann. Inst. Pasteur.* 1921. Mar. Vol. 35. No. 3. pp. 193–203. With 1 coloured plate, comprising 18 figs.

The nature of the piroplasm first figured and described by THEILER under the above name, has been very differently conceived by various

authors, and before undertaking experimental investigations, it appeared necessary to obtain some precise information with regard to the morphological types encountered and endeavour to determine the developmental stages. Over 1,000 small piroplasms were therefore drawn and measured, and the number of infested red corpuscles was at the same time noted. The blood was obtained from six Algerian cattle from fifteen months to three years old. Three of these animals were in apparent good health, and three suffered from various infections which had no apparent connection with the *mutans* infection. No other blood parasite besides the small piroplasms corresponding to the accepted definition of these organisms were encountered. The piroplasms could be classified in three large groups, viz. :—

(1) Rounded, oval, or elliptical elements which merged into dividing forms. A single large vacuole constantly present.

(2) Rod-shaped elements containing no vacuole, with a long nucleus occupying half the total length of the body. Binary division frequently seen.

(3) Rod-shaped elements possessing the characters of gametes.

The 1st Group. This group contains a number of differently shaped elements in various stages of development.

(1A) The smallest forms visible, which were less than $0{\cdot}33\mu$ in diameter, were rounded, or rather in the form of a ring composed half of chromatin (red), and half of cytoplasm (blue), surrounding a central vacuole. All ring-shaped forms less than 1μ in diameter are classed among these young forms.

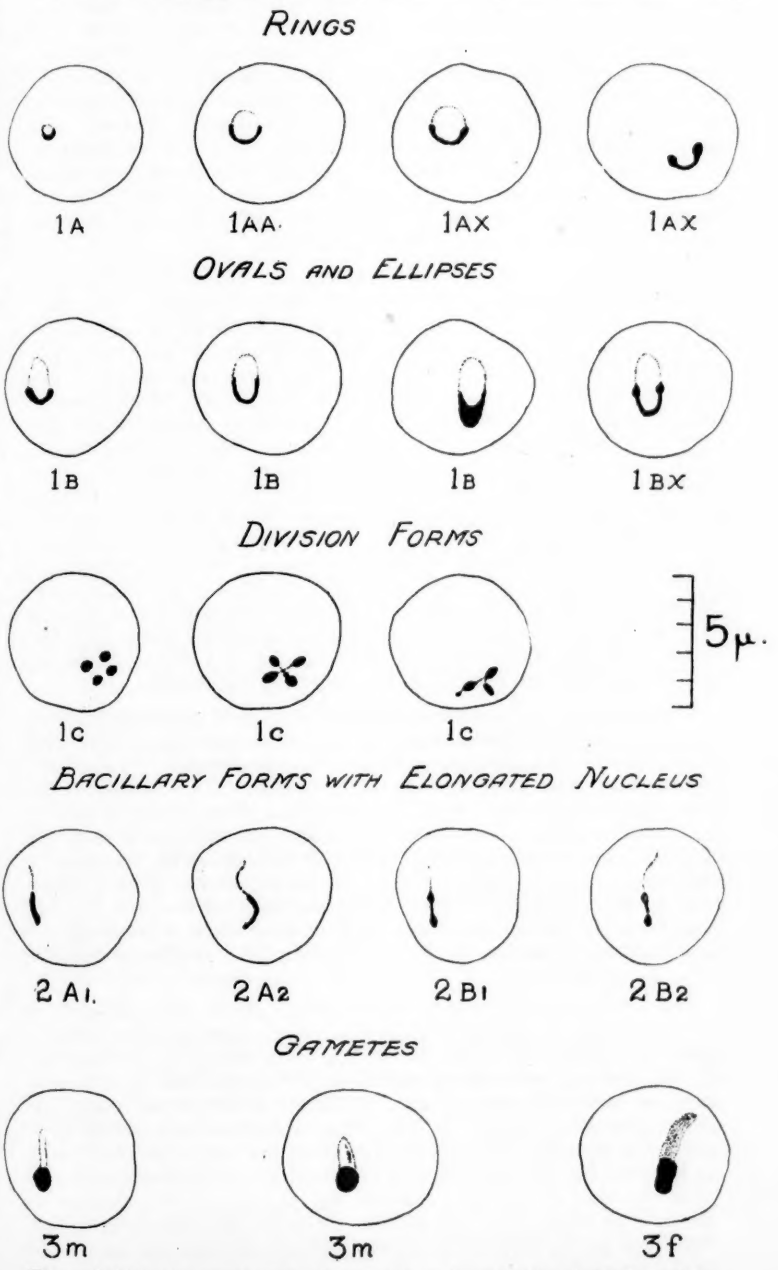
(1AA) The same ring-shaped forms are again found, of similar appearance, with increasing dimensions reaching up to 2μ in diameter, the average diameter being $1{\cdot}6\mu$.

(1B) Besides ring-shaped elements, forms presenting the same structure, but which, instead of being circular in shape, are oval or elliptical in shape, are seen, the average dimensions being $2{\cdot}4$ by $0{\cdot}8\mu$; maximum length, $3{\cdot}5\mu$, minimum, 1μ; maximum breadth, 1μ, minimum 4μ. The nucleus and the cytoplasm, instead of forming two semicircles, describe two horse-shoe shaped figures which are contiguous at their extremities. In the elliptical forms, the chromatin describes sometimes a crescentic figure, instead of a horse-shoe shaped figure. One of these elliptical forms with crescentic nucleus was found in an extra-corpuscular situation. The cytoplasm of the oval forms was sometimes twisted like a blown flame and thus, apparently, it was capable of executing whip-like movements. The oval and elliptical forms correspond, perhaps, with ring-shaped forms disturbed by pressure or other special condition upsetting equilibrium.

(1AX) (1BX) The development of both the ring-shaped forms and of the oval or elliptical forms, leads up to the appearance of dividing forms. The semicircle or semiellipse of chromatin shows two, three, or four dot-like swellings, between which delicate chromatin threads persist for a long time.

(1C) Ultimately, groups of four (rarely three) chromatinic granules are seen, which stain a deep red colour and are arranged in the form of lozenges, each $1{\cdot}5\mu$ in average diagonal measurement; no trace of cytoplasm is seen, but the remains of the delicate loose chromatin is often seen stained a pale rose colour. These pale rose-coloured filaments join up sometimes the red granules in twos, and thus resemble two parallel dumb-bell-shaped structures. Sometimes all four are united together in this manner, so as to describe the borders

Forms of *Piroplasma* (*Gonderia*) *mutans*. [After EDM. SERGENT.]



The solid black represents chromatin red, and the dotted portion the blue-staining cytoplasm.

[From a coloured plate in the *Annales de l'Institut Pasteur*.]

of an irregular quadrilateral figure. The rose-coloured filaments are never arranged diagonally in the groups of four elements. The four granules are of an irregularly oval and angular shape. They are practically never all four situated in the same plane. Only on two occasions were cross-shaped structures seen (the limbs of the cross were stained blue, the extremities terminated in the red granules). In the first case, viz., the irregularly cross-shaped form, four large chromatin granules, plus a fifth small granule on one of the limbs of the cross were seen. In the second case, the blue threads described an L-shaped figure, with three chromatin granules occupying the extremities and the summit of the angle. A fourth small granule marked the middle of the smaller blue branch.

The 2nd Group. In the second group, the youngest elements are in the form of small chromatin rods less than 1μ in length. Bacillary forms, on an average 2·4μ long by 0·2 or 0·3μ broad, are especially in evidence. Maximum length, 4μ, minimum, 1·3μ; maximum breadth or width, 0·6μ, minimum, 0·4μ. Contrary to what has been described in the case of the majority of the bacillary forms hitherto seen, the nucleus is not rounded, but is elongated in the form of a linear rod occupying about half the length of the parasite, which hence has the appearance of a half-red, half-blue rod. In a third of the cases (190 out of 559 parasites), the long nucleus is marked at its extremities by two deeper red points, which causes the parasite to resemble somewhat a drum stick. These forms are figured in B1 and B2 (190 out of 1,369, or 13·88 per cent. of the total number of parasites, assumed this shape). Finally, about a third of the cases likewise (203 out of 559 times, the bacillary form with linear nucleus, whether this be compact or containing two granules), show whip-like movements—figs. A2 and B2 (203 parasites out of 1,369, or 14·83 per cent. of the total number of parasites assumed this shape).

The 3rd Group contains elements which seem to be derived from these bacillary forms, presenting ultimately the characters of gametes, being composed of microgametes (fig. 3M), with large alveolar or vacuolated nucleus and clear loose vacuolated cytoplasm. The smaller forms with rounded nucleus, which represents a form very frequently described by authors, were only quite seldom encountered in Sergent's observations, average dimensions, 2·3 by 0·5μ; maximum length, 2·8μ, minimum, 1μ; maximum breadth, 0·6μ, minimum, 0·3μ. Microgametes (fig. 3F), with a loose and not abundant nucleus and compact cytoplasm stained a deep blue, were seen, average dimensions, 2·5 by 0·9μ; maximum length, 3·3μ, minimum, 2μ; maximum breadth, 1·3μ, minimum, 0·3μ.

The same types of parasites as described above were encountered in all six oxen examined, but the relative proportion of the different types varied from one ox to another. For example, in two oxen the relative numbers of parasites falling into these three groups were, rounded forms 79·96 per cent., bacillary forms 9·3 per cent., and gametes 10·73 per cent. In four other cattle they were 24·93, 62·59 and 12·46 per cent. respectively. In the case kept under observation no information could be obtained connecting the predominance of a particular form at any given moment with the age of the animal, or the presence or absence of any morbid state, or the season of the year. Variations in the proportions of the parasites present had no relation to the temperature curve.

The author then endeavours to interpret the significance of the various forms observed.

The first group of rounded, oval, or elliptical parasites, he considers to represent the commonly found schizogonic forms of *P. mutans*.

The second group of rod-shaped elements with whip-like movements are young elements which are capable of showing binary division, analogous to that which is sometimes observed in the young Plasmodium in malaria, thus furnishing the parasites, in certain undetermined circumstances, with a second means of asexual reproduction.

The third group of rod-shaped elements leads up to the formation of gametes.

Anaplasmatic forms. Out of 229,800 red corpuscles examined, there were observed, besides the 1,369 small piroplasms, 15 structures, which would appear to correspond to the definition given to anaplasms as well as to that of Jolly bodies. The average diameter was 0·9μ, largest 1·3μ, smallest 0·25μ. Their presence in the animals did not coincide with any pathological or abnormal state. They much resembled the chromatin granules found in the quaternary groups described above. But there were certain differences in shape: the anaplasmatic form was well rounded, whilst the granule which resulted from the division of the chromatin was still, up to the time the group became scattered, angular and irregular.

Blood corpuscles. The degree of infection according to the above figures would come to 5·9 parasites per 1,000 red corpuscles. The maximum did not exceed 20 per 1,000 corpuscles. This proportion was observed in a heifer affected with purulent peritonitis, but infection was likewise seen in a heifer in very good health, which harboured 2 per 1,000 on an average over a period of a year, and at certain times, without any apparent reason, the proportion rose to 16 per 1,000, and then became re-established back to the original amount. Sometimes over 20,000 red corpuscles had to be examined before a parasite could be found. The most marked blood lesion was anisocytosis. Sometimes corpuscles undergoing punctate degeneration were observed. The infested corpuscles did not show any particular changes. Some were smaller, others were larger, than a corpuscle of average size. Average diameter 4·9μ, maximum 6·5μ, minimum 4μ. In 12 cases there was double invasion of the red corpuscle. On eight occasions the two parasites were one ring-shaped and one oval, while in four cases they were both rod-shaped. Microscopic examination of gland-juice taken during life, or after death, together with, in this last case, spleen pulp, never showed any Koch's bodies, which characterises invasion by *T. parva*.

DU TOIT (P. J.). **Experimentelle Studien über die Pferdepiroplasmose. III. Mitteilung. Übertragungsversuche mit Zecken bei der *Piroplasma caballi* Infektion.** [Experimental Studies on Equine Piroplasmosis. 3rd Communication. Transmission Experiments with Ticks in Cases of *Piroplasma caballi* Infection.]—*Arch. f. Schiffs- u. Trop. Hyg.* 1919. Vol. 23. pp. 359–368. With 1 fig.*

The experiments were instituted in order to estimate the danger of *P. caballi* infection following upon its possible introduction into

* Abstracted by Mr. S. C. J. Bennett, B.Sc., M.R.C.V.S.

Germany from the Balkan theatre of war. They follow previous work by the same author [see this *Bulletin*, 1919, Vol. 7, No. 3, p. 140], in which he demonstrated the small danger threatened by *Nuttallia equi* infection, owing to the non-transmissibility of this parasite by the tick most commonly found in Germany, viz., *Ixodes ricinus*.

The first series of experiments were conducted with *Ixodes ricinus*. Larvae hatched from the eggs of female adults which had been fed on a horse with *P. caballi* infection failed to transmit the piroplasms to a healthy horse. Further, the same ticks, fed on an infected horse as nymphs, failed to transmit the disease as adults.

It was unfortunately impossible to determine whether ticks infected as larvae could prove virulent as nymphs; the larvae took an extraordinarily long time to moult, and the author's enforced absence from Germany made it necessary to leave this question in abeyance.

The tick which served for the second series of experiments was *Dermacentor reticulatus*. Specimens of adult females had been sent from Macedonia, a district in which *D. reticulatus* is normally the carrier of *P. caballi* infection. As previous studies with this tick had not warranted unequivocal conclusions, confirmatory experiments were decided on.

In the first experiment, larvae were fed on a horse suffering from *P. caballi* infection. After moulting they were placed on a sound horse. This animal developed typical symptoms of piroplasmosis, with parasites in the blood at the end of ten days. The nymphs were collected and stored in order to ascertain whether they had "cleansed" themselves of the infection. With this object in view, the adults which developed from these nymphs were placed on a healthy horse. The ticks refused to attach themselves to their new host, the reason being, in the author's opinion, that it was the wrong season of the year. *Dermacentor reticulatus* is most active in the spring, and this experiment was attempted in the autumn.

Assuming this explanation to be correct, the ticks were stored through the winter and put on a healthy horse the following April (1919). Although only one female became gorged, the horse developed symptoms of piroplasmosis with parasites in the blood at the end of thirteen days.

The experiments with *Dermacentor reticulatus* are of considerable importance. In the first place, it is undoubtedly a transmitting tick in cases of *P. caballi* infection; moreover, the disease is transmitted by two successive developmental stages of the tick without any renewal of infection in between. It appears that this is the first recorded case of persistence of infectivity in a tick of the family *Ixodidae* during two successive stages. It is pointed out that ticks of this family may retain their infectivity over two stages, or even over the whole life-cycle, as in the case of *Haemaphysalis leachi*, which takes up *P. canis* infection as an adult, and is infective to susceptible hosts in the next adult stage. But, and particular attention is drawn to this point, no other case is known of a tick of this family being infective at two *successive* stages of the life-cycle.

The conclusions drawn from the above-mentioned experiments are that there is little danger to be feared in Germany from equine piroplasmosis, as the common indigenous tick, *Ixodus ricinus*, is a carrier

of neither *Nuttallia equi* nor *Piroplasma caballi*. With regard to *Dermacentor reticulatus*, this tick is undoubtedly a transmitter of *P. caballi* infection, which it takes up in one stage and passes on at the next stage; moreover, as shown above, there is a danger of its being infective even at the next stage as well.

DISEASES DUE TO METAZOAN PARASITES.

PATTON (W. S.). **Some Notes on the Arthropods of Medical and Veterinary Importance in Mesopotamia and on their Relation to Disease. Part 1. The Gad Flies of Mesopotamia.**— *Indian Jl. Med. Res.* 1920. April. Vol. 7. No. 4. pp. 735–750. With 1 plate comprising 2 figs., 5 text figs., and 1 map.

Whilst serving with the late Mesopotamia Expeditionary Force from November 1915 to August 1917, Patton (Director, Pasteur Institute of Southern India, Coonoor) collected a large amount of entomological material which he now describes in a series of articles. Dealing first with the Tabanidae or gad flies it might appear at first sight, he states, that the country, on account of its peculiar topography and climate, would be rich in species of this family. The riverine belts of vegetation, with their many creeks and watercourses, and the extensive marshy areas would seem to be ideal breeding grounds for these flies, but, nevertheless, only eight species, belonging to three genera, were found, and only two of these species were represented in large numbers. This fact might be explained away by the lack of sufficient cover and the scarcity of suitable animals to feed upon, and a point in support of this suggestion is that only two specimens of a dark species of Haematopota were taken, and it is well known that this species prefers usually a somewhat dense scrub which is certainly absent in Mesopotamia. The following were the important tabanids examined :—

Tabanus pulchellus Lw. (*T. cyprianus* Ric.). A small light-grey species with yellow legs and clear wings; frontal stripe broad, with two small round calli; abdomen with four somewhat indistinct spots, sometimes appearing as stripes on each segment. The species closely resembles the widely-distributed and oriental ethiopian *ditoeniatus* Macq., and it is probably only a local race of this fly. It has been recorded from Cyprus under the name *cyprianus*, from Seistan and from Persia, where it is said to be a common horse fly, and it also occurs in Algeria. It is widely distributed in Mesopotamia and it is, together with the next described species (*T. glaber*), one of the most important insect pests. It appears early in April in small numbers, and later in the season it is extremely common, only disappearing in September and early October. In the marshy areas along the Euphrates it swarms in great numbers and bites from early morning till dusk, and lays its eggs in enormous numbers on various objects such as wooden stakes. Mules and horses in a certain camp in these areas suffered severely from the effects of the bites of these flies and as a result became anaemic and thin. Various deterrents were tried, but with little success, and the only certain means of protection was housing the animals in reed huts. The females travelled long distances from their breeding grounds into the desert, and were caught on many occasions from five to six miles away. Were it not for a large species

of bee-eater which fed on the flies, and the myriads of large dragon flies which also devoured them, it would have been impossible to have kept animals in the camp.

Tabanus glaber Bigot. A small dark-reddish species with black legs and clear wings. Frontal stripe somewhat narrow with three distinct calli; abdomen with a dark central stripe. Recorded from Afghanistan, Kashgar, Eastern Turkestan, Seistan, and Persia; widely distributed in Mesopotamia. It was very common during the end of the season from about August to November. Large numbers were caught on dromedaries in a camp in the neighbourhood of Nasiriyah, and these animals were at the time suffering from trypanosomiasis; all eventually died or had to be shot. The species was breeding along the banks of a creek in the vicinity of the camp. It does not appear to breed in marshy areas.

Tabanus polygonus Walker. A large reddish-brown species with light central triangular spots on the abdomen; wings clear; frontal stripe with a broad square callus at the base and a narrow black stripe extending, as a rule, from its upper border, but sometimes free. This species was first described from Baghdad, but it was found to be common all over the country. It could always be caught on horses and mules from March to September. It mainly breeds along the banks of creeks.

Tabanus pulverifer Walker. A rather small species with grey spots on the abdomen. Comes very near the European *Tabanus cordiger* Weidemann, but differs from it in some respects. Only one specimen of this species was taken in the marshy area along the Euphrates, not far from Kurnah. It is recorded from Baghdad and from Turkey in Asia.

Tabanus persis Ricardo. A small species, superficially resembling *T. pulchellus,* with yellow legs and clear wings without an appendix; abdomen greyish with light central and lateral stripes; frontal stripe broad with two well-marked broad calli. Recorded by RICARDO from Afghanistan, Seistan, and Persia, and is said to be common on horses and camels. In Mesopotamia it was almost always found in company with *pulchellus,* but never in large numbers. It breeds in the same places, and it seems probable that the small numbers as compared with those of *pulchellus* may be due to the larvae being outnumbered by those of that species.

Tabanus sufis Jennicke (*T. alboventralis* Newstead). A small blackish-grey species with yellowish legs and clear wings; frontal stripe very broad with divergent sides, with a large black basal callus and two round central ones placed side by side. Abdomen blackish-grey with a median dark line and diffuse spots. Recorded by SURCOUF from Jerusalem, Abyssinia, the Anglo-Egyptian Soudan, Mauretania (Morocco and Western Algeria), Senegal, and from Gambia by NEWSTEAD under the name *alboventralis.* Found in many parts of Mesopotamia, though not a common species. Breeds along the banks of creeks and along watercourses.

Chrysops punctifera Lw. A small greyish-yellow species with golden pubescence; antennae mostly dark brown. Thorax with two dark lateral bands. Abdomen yellowish, second segment with a V-shaped spot; legs yellowish, wings white, costal border brown, with one clear oval spot occupying almost the whole of the discal cell. This species was common at Basra along the creeks and watercourses during the months of April and May; it was also present along the Euphrates and Tigris.

Haematopota. Only two specimens of this genus, and these males, were taken during the whole time the author was in the country.

Gad flies, and the trypanosomiasis of dromedaries in Mesopotamia.

During the late campaign more than 1,000 dromedaries belonging to the various camel corps in the country were lost as a result of a very fatal form of trypanosomiasis. The disease was widespread, occurring along the Karun, Euphrates and Tigris. The dromedary, as is well known, is one of the animals most highly valued by the arab, and particularly by the desert nomad whose very existence depends on it. There are two types, the riding variety, which is highly bred, of light build, and capable of great and continuous exertion, and the baggage variety, of heavy build, capable of carrying from 300 to 600 lbs. if properly loaded. The milk and flesh of these animals constitute the desert arab's food and the hair his warm clothing. The nomad arabs living in the desert areas bordering the rivers, particularly the Euphrates, breed these animals in large numbers, and many of the influential Sheiks own 1,000 or more head. It would seem that trypanosomiasis and its association with the bite of the gad fly is well known to these Sheiks, for in one instance at least the author found that although the animal mortality in a large herd amounted to 8 to 10 per cent. per annum, none of them died from trypanosomiasis. In this herd 1 per cent. of the dromedaries was over 9 years old, 5 per cent. were over 8, and the remainder under 6 years. The animals over 10 and up to 14 years were always killed and eaten. The owner brought his dromedaries to drink daily to a water hole a few miles beyond the head of a creek at dusk. The gad flies which formed a considerable belt along the water course had then stopped biting and the dromedaries were taken back to camp, which was well beyond the fly belt, immediately after they had been watered. In this way no animal was ever lost from trypanosomiasis. The dromedaries belonging to various camel corps, however, had to be kept well within this belt, and as a result they all became infected and died. Among them, however, were a few Sind dromedaries, and none of these appeared to become infected although some had been there during two fly seasons. This would suggest that they were immune to the Mesopotamian variety of trypanosome.

In one camp situated close to the Euphrates, just above Nasiriyah, a number of animals recently purchased from an Arab Sheik were collected in July to October, and very soon they began to sicken and show large number of trypanosomes in their blood. *T. glaber* was found in large numbers feeding on the dromedaries, and, except for a few specimens of *T. pulchellus*, it was the only species seen. There were no other biting flies, but there were large numbers of a new species of haematophagous *Musca*. These conditions seemed to be ideal for studying trypanosome transmission. A large number of specimens of *T. glaber* were collected, and it was found that 100 per cent. were infected with a species of Crithidia closely resembling *C. tabani* Patton. A large percentage contained the characteristic post-flagellate stages massed in the hind gut, and the contents of the rectum contained large numbers of flagellates. No true trypanosomes were found in the flies and there were no parasites in the salivary glands, indicating that the trypanosome did not undergo any developmental changes in the flies.

From previous studies on the Crithidia parasitic in gad flies, the author had found that they were acquired by the adult flies in the

act of sucking blood. It was, therefore, only necessary on this occasion to watch these flies feeding to see that this was probably the only way by which they became infected. *T. glaber*, as well as most gad flies that attack dromedaries, bite them on the belly, chiefly in the neighbourhood of the genital organs, udder and sheath, and inside the thighs. As the flies feed they eject a dark fluid, sometimes pure blood, from their alimentary tracts on to the skin and hair of the animal, where it can be seen as sticky drops. This fluid on examination proved to contain large numbers of flagellates, and the post-flagellate stage referred to above was seen. Before sucking blood the flies searched for a suitable spot and applied their labella to the hair and then to the skin, and in this way ingested the Crithidia. The dromedaries were noticed to drive away the flies by licking the sites bitten, and at each such act they would infect their lips with the various stages of the parasite. It therefore seemed that the trypanosome in the blood of the dromedaries might be nothing else than a stage of these Crithidia parasitic in the fly, and that when this parasite came into contact with the mucous membranes of the mouth, it penetrated into the blood and there assumed the trypanosome stage. It has been repeatedly demonstrated by many authors that Herpetomonas and Crithidia can find their way into the blood by way of the alimentary tract, and it is known that trypanosomes can penetrate the mucous membranes.

There appears to be sufficient evidence also to show that two of the commonest non-pathogenic trypanosomes of domesticated animals are stages in the life-cycle of flagellates which are also represented in other stages as Crithidia in the alimentary tract of tabanid flies [see also p. 69 of this number. NÖLLER claims to have proved that the non-pathogenic trypansome (*T. theileri*) of German cattle is represented during a stage in its development as a flagellate in the gad fly, *Tabanus glaucopis* Meig. (this *Bulletin*, 1917, p. 15), and later he demonstrated that the sheep trypanosome, *T. ovis*, assumed a crithidial form in the gut of the sheep-ked *Melophagus ovinus* L. (this *Bulletin*, 1919, p. 135).—ED.]

The author attempted to carry out an experiment to substantiate this hypothesis under very imperfect field service conditions. Two young dromedaries known to be free from trypanosomes were isolated for two months in a camp known to be free from flies on the left bank of the Euphrates at Nasiriyah, and at the end of this time they were still free from trypanosomes. A large number of specimens of *T. glaber* were collected from the camp mentioned above and dissected, and the various stages of the Crithidia, obtained only from the hind guts, were placed on the buccal mucous membranes of these animals. Unfortunately the experiment could not be carried to a conclusion. [In order to ascertain the infectivity of these crithidial forms it seems strange that the author did not attempt transmission in the first place by subcutaneous inoculation before attempting the more difficult mode, viz., by the intact mucous membranes.—ED.]

The author then gives an interesting summary of the literature dealing with trypanosomiasis of dromedaries in other parts of the world, and our own present knowledge of the method of transmission of the causative agents. The large mass of evidence seems to point to gad flies as the vectors, but the mode of spread by the flies is by no means clear. Our present knowledge appears to be that gad flies only act as mechanical carriers, and that the trypanosomes soon

disappear from their alimentary tracts, and that only those parasites that chance to be on the labella and prestomum are carried to healthy animals. If this is the case, then, the author maintains with reason that it is difficult to understand why the gad fly is the only certain carrier, when it is known that many other species of biting flies are just as intermittent in their feeding habits, for example, the many species of Stomoxys and the haematophagous species of the genus Musca, which are always present in the company of biting flies all over the world. It should be noted also that all feeding and transmission experiments with gad flies have been carried out with wild specimens, and not with flies bred in the laboratory. [The author omits one important reference concerning the transmission of trypanosomiasis by tabanids, viz., that of MITZMAIN, who carried out investigations on surra transmission in horses and other animals in the Philippine Islands, and seemed to have proved beyond doubt that *Tabanus striatus* Fabr. acted as a mechanical carrier, and that *Stomoxys calcitrans* particularly and other biting flies do not act as vectors (this *Bulletin,* 1918, Vol. 6, No. 4, p. 224).—ED.]

The author suggests certain definite lines of investigation, but, unfortunately, in the case of gad flies, this would be met with difficulty owing to the fact that there is considerable trouble in rearing the early stages to maturity, as most of their larvae are predaceous. They are not easily found in nature in sufficiently large numbers, but they can be bred out by keeping each larva in a separate receptacle.

Control of gad flies in Mesopotamia. The dromedary owners in Mesopotamia avoid the fly areas and are well acquainted with the belts along the rivers where the gad flies abound, particularly in the summer months. Their animals are kept outside these belts, and they are only brought into them to be watered at dusk, and are always driven away before the flies appear in the morning. If forced to graze their animals in the infected areas, they do so only in the early morning and late evening, when only stray specimens of the flies are on the wing. As the breeding grounds of the flies cover enormous areas of country, it would be quite impossible to attempt to destroy the early stages. Much might be done, however, to destroy the eggs by introducing into the country certain species of Chalcids which are parasitic on the eggs of the flies. It is also well to remember that the tabanid-infested areas represent a source of danger for horses.

The author kindly offers to give interested persons further advice regarding the gad flies of Mesopotamia, and to identify any specimens sent to him.

PATTON (W. S.). **Some Notes on the Arthropods of Medical and Veterinary Importance in Mesopotamia, and on their Relation to Disease. Part II., Mesopotamian House Flies and their Allies.**—*Indian Jl. Med. Res.* 1920. April. Vol. 7. No. 4. pp. 751–777. With 4 plates and 6 text figs.

"Mesopotamia, in addition to being renowned as the birthplace of the human race, also enjoys the unenviable reputation of being the home of the house fly." The extraordinary rapidity with which flies appeared in myriads in camps is familiar to those who went through the recent campaign. In this paper Patton describes the various species of house flies and their allies which are of economic importance,

and sets forth in some detail the best measures for controlling these insects.

(*a*) *Musca determinata* Walker. A typical member of the genus, with four black thoracic stripes and closely resembling the European species *Musca domestica*, but differing from it in some small but definite details. This species was first described by WALKER in 1856 from the West Indies, and has since been recorded from various localities in India and is probably widely distributed, being common throughout Mesopotamia, Aden, Egypt, and probably Palestine. The egg of this species is exactly similar to that of the common house fly, and is 1–25th of an inch long. The full-grown larva is creamy white, and ½ inch long. The eggs are laid in batches of 150–250 or more, and oviposition is complete after two to four such batches have been laid. During the summer months, in Mesopotamia, the eggs hatch out in from six to eight hours, the larval stage lasts 36 to 42 hours, and the adults emerge 36 hours after pupation. Under such conditions, and with a rich food supply, one generation succeeds another in from 72 to 90 hours. In the cold weather all the stages are retarded.

As the result of a long series of feeding experiments carried out in the field, Patton found that the following larval foodstuffs were selected by the adult female for oviposition in their respective order of predilection: (1) Human excrement, and the green partly-digested food from the stomachs and intestines of cattle and sheep; (2) horse and mule droppings; (3) decaying vegetables, tea leaves and other kitchen refuse; (4) cow dung, which was utilised only to a small extent, and apparently in the cold weather only, when it was collected in large heaps. The larvae pass down into the food mass and remain hidden from view, but during the night come up to the surface, and when they have eaten through a mass of horse dung it presents a characteristic appearance. The heap, which is probably irregular at the surface, becomes flattened out and presents a worm-eaten appearance, due to the larvae having passed through it over and over again. This is a point of practical importance, as it enables an observer to detect a breeding ground with certainty. The mature larvae, after a short resting period, migrate, usually at night, and crawl away to select a suitable nidus in which to pupate. Sometimes, however, they pass down into the earth directly below the mass, provided it is moist and there are cracks into which they can insert themselves. The extraordinary power the larvae have of burrowing into the earth, even when hard, is remarkable. The adults, on hatching, nearly always collect together in the vicinity of the breeding grounds, when copulation takes place, and they then scatter to their feeding grounds. This is considered to be another point of practical importance, for if one finds a small swarm of house flies collected together in any locality, and more particularly if they fly on to any moving objects and settle in a clump, they are almost certainly recently hatched flies, and the breeding ground will be found near by.

(*b*) *Musca humilis* Weid. A widely-distributed species, probably even more so than the type species of the genus (*Musca domestica*). It is a small to medium-sized greyish species, with two black thoracic bands and a chequered abdomen. Found along the Northern African coast; a common bazaar fly in Egypt and the Soudan, in Port Said, Aden, and the Aden Hinterland, and in many parts of India; occurs throughout Mesopotamia and probably in Palestine; also found in many parts of China and in Australia. It forms a connecting link

between the house fly group and the haematophagous species. It may be seen on horses and cattle, feeding on sores and cuts and on the blood which exudes from the bites of true biting flies. It was described by THOMPSON from China under the name *angustifron*, and the author also found it to be identical with the specimens described under the names *Musca euteniata* Bigot, and *M. conducens* Walker; probably also with *M. precox* Walker. The egg and larva of this species are so similar to those of the previously described one that it can hardly be differentiated, but there are some few technical points of difference. The eggs are laid in somewhat smaller batches, otherwise their life-histories are very much the same. The larvae are capable of developing into maturity in many foodstuffs, and may be found in cow dung dropped in the field, in heaps of horse manure, in human excrement, and in the green partially-digested food of the alimentary tracts of sheep and cattle.

In Mesopotamia, house flies are responsible for an appalling amount of ophthalmia among the human population.

There are many weak points in the life-history of the house fly. It is a gregarious insect, lays its eggs together in masses in foodstuffs suitable for its larvae, and the latter, on hatching out, keep together and later migrate from the breeding ground in order to pupate. They can only reach maturity when the temperature, moisture and fermentation conditions are at their optimum, and an increase of one of these factors reacts on the other and upsets the balance.

The author then describes how, after studying the life-histories of the two house and camp flies in Mesopotamia, the prevention of breeding and the destruction of flies was accomplished at Nasiryah—observations which later led to the successful control of these insects throughout the occupied parts of the country. The methods depended largely on the burning of all human excreta, of equine droppings, and especially of the contents of the viscera of slaughtered animals. The precautions to be observed in working the incinerators, preferably covered, are described. In hot weather the horse manure is first spread out on dry ground in order to dry it in a uniform layer, about four inches deep, turned once or twice, and immediately burned in the incinerators. In the cold weather this could not be accomplished owing to the heavy dews, and the biological method of dealing with manure, in which it is used to breed and at the same time to destroy the house fly larvae, was adopted. This method has been employed especially by ROUBAUD. Large quantities of fresh manure were heaped into mounds varying from 20 to 25 feet in height and 30 to 40 feet in circumference, with flat tops. Each mound was placed on a selected piece of hard ground, and consisted of a two-days' collection of fresh manure. On the third day the manure from the centre of mound No. 1 was removed and the fresh manure of the day buried in the hole, and covered with the hot manure. This was done in the case of each of the other mounds. By the time the last mound was thus utilised No. 1 and part of several others had been removed and burnt in the incinerators, and fresh mounds started. In this way the fresh manure was each day exposed to the heat and gases in the mounds, and all eggs and larvae were destroyed. It was soon found, however, that the above two species of flies began to breed on the layer of manure on the outer surfaces of the mounds, but they could not penetrate for more than four or five inches on account of the great heat. A small shallow trench, six inches wide by four inches

deep, with straight steep sides, was therefore constructed to encircle each mound, and it was found that the larvae, on trying to leave the mound, fell into the trench and had to pupate in it, as they could not scale the sides. A thin layer of dry manure was spread along the bottom in order to encourage them to remain in the trench. Each morning, manure containing the larvae and pupae was swept up with small brooms and buried in the hole of a hot fermenting mound. The results of these experiments induce the author to recommend thoroughly the so-called bio-thermic method for dealing with large quantities of horse manure, particularly in tropical countries.

In order to destroy larvae in semi-liquid material, such as the partially-digested food from the viscera of slaughtered animals, it was found only necessary to dig a trench six feet deep by four feet wide by 10 feet or more long and leave it for a night. Next morning it always contained from two to four feet of water, depending on the locality, and the larvae and pupae were readily drowned.

Methods are then described for dealing with the adult insects, and these comprise the use of kerosene oil torches for burning the flies on the inside of the walls of buildings, erection of roofs under which the flies would collect and could then be burned at dusk, and the use of properly constructed and baited traps. The green partially-digested food material from the stomachs and intestines of recently slaughtered cattle, was found to be most attractive bait.

A new species of haematophagous fly, *Musca mesopotamiensis*, is briefly described. This is a comparatively large species superficially resembling *Musca pattoni*, but readily distinguished from it by the width of the front in both sexes. The egg of this fly is also very similar to that of *M. domestica*, but is much larger and is characterised by the absence of a spine. The mature larva is creamy white in colour and measures $\frac{5}{8}$ths inch. The eggs of this species, some 30 in number, are always laid singly in patches of cow dung dropped in the field. The larvae, when ready to pupate, migrate from the patch and bury themselves very deeply in the ground some distance from, or sometimes below, the patch of dung. Puparia collected during the end of October and in November, and kept in some earth did not hatch out until the following March. The flies disappear in November and only reappear during the early days of March. No larvae could be found in patches of cow dung during the cold weather, but on the other hand it was possible to find puparia in the ground near the old patches.

The species, therefore, hibernates during the winter in the pupal stage. As mentioned in the preceding extract, large numbers of this species were seen on camels feeding on the exudation of sores, eyes, etc., coming from the bites of the true biting flies. Both sexes may be seen on cattle, horses, mules, and donkeys, flying from one animal to another and worrying biting flies to try to induce them to withdraw their probosces before becoming replete with blood. In this way it is considered that the species may be the vector of disease-producing organisms. The flies were never seen in tents, houses, or bazaars.

Two more muscid species are mentioned, viz. (1) *Musca tempestiva* Fallen, a small, dark grey species, with four black thoracic bands. Widely distributed in Europe, common in Mesopotamia, and can always be seen in the summer months on horses and cattle following biting flies and behaving like *M. mesopotamiensis*. Its early stages are not known, but as it was often seen sitting on patches of cow dung, it is very probable that it breeds in this substance ; (2) *M. vitri* Meigen,

a small metallic species, probably not belonging to Musca but to Claxemyia. The eyes in the male are hairy; widely distributed in Europe and Africa, and common throughout Mesopotamia, and, like the preceding species, seen on horses and cattle following biting flies and sucking up any blood exuding from the bites. Its early stages are not known, but it probably breeds in patches of cow dung. It is very probable that these two species occur in Northern India.

Only one species of the genus Philaematomyia, viz., *P. crassirostris* Stein (*insignis* Austen), was seen, and it was very plentiful on cattle all over the country. This fly is of a greyish-yellow colour with light thoracic stripes, especially in the female, while the thorax in the male is much darker and the stripes are better marked. The female eyes are widely separated, and the species can be distinguished also from a Musca by examining the proboscis, for the mentum is well marked, while in Musca it is feebly developed.

Only one species of the genus Stomoxys, viz., *S. calcitrans*, was met with in Mesopotamia, and this fly can be easily recognised while it is biting horses and cattle by noting that it keeps its wings well apart, and the long proboscis cannot be missed. This fly was a great pest at Nasiriyah during the flood season.

Lyperosia exigua, a slate grey to dark grey, large species, is widely distributed throughout Asia, India and Mesopotamia; commonly seen sitting on the shoulders of cattle with its head directed downwards. *L. minuta*, a small, dark grey species, is found throughout India and many parts of Africa, and is very common in Mesopotamia.

Blow-flies.—*Calliphora erythrocephala* Macq., the well-known European bluebottle, or blow-fly, was very common during the summer months, laying its eggs in meat, dead bodies of animals, offal and other animal refuse.

Chrysomyia (*Pycnosoma*) *albiceps* Weid., a medium-sized bright metallic-green species, is common all over the country, and breeds in the same situations as the last-named fly.

Lucilia sericata Meigen, the well-known sheep blow-fly, a medium-sized bright metallic-green species and very widely distributed; of great economic importance on account of its habit of laying eggs in the soiled wool of sheep, and thus causing considerable loss to farmers. Was never observed to do this in Mesopotamia; this was probably due to the fact that it had much other animal matter always available in which to lay its eggs. Many specimens of larvae were collected from wet mud contaminated with the urine of horses, and the typical adults were bred out of these. It could not be bred in the bodies of dead birds or small animals. The blow-flies, it is stated, can be readily controlled in the places where they breed. All dead bodies of animals should be burnt, and the same should be done with meat offal, etc.

Flesh flies (Sarcophagidae). These can always be recognised by their grey colour and often reddish eyes, striped thorax, and chequered or spotted abdomen. Two important genera are found in Mesopotamia, viz., Sarcophaga and Wohlfahrtia.

Sarcophaga haemorrhoidalis Fallen, was very common during the height of the hot weather, when dromedaries affected with trypanosomiasis were dying in large numbers. Owing to the lack of fuel the bodies of these animals had to be buried, and as this was a difficult task the fly found in them an excellent breeding ground for its larvae. Females deposit their larvae in the bodies long before decomposition

sets in. *Wohlfahrtia meigenii* Scheiner, a large grey Sarcophaga-like fly, with characteristic round spots on the abdomen, was very common all over Mesopotamia, and deposits its larvae in the dead bodies of animals. Other species of this genus have been recorded as attacking man and animals and depositing their larvae in sores, and even in the eye, but no cases of myiasis caused by the larvae of this species were seen.

PATTON (W. S.). **Some Notes on the Arthropods of Medical and Veterinary Importance in Mesopotamia, and on their Relation to Disease. Part III. The Bot Flies of Mesopotamia.**—*Indian Jl. Med. Res.* 1920. July. Vol. 8. No. 1. pp. 1–16. With 2 plates comprising 4 figs.

THE HORSE BOTS.

Gastrophilus intestinalis var. *bengalensis* Macq.—This is a large tawny-yellow species resembling the common European horse bot (*Gastrophilus intestinalis*) in appearance, but of a lighter colour and smaller in size. The morphology is described in detail; the egg of this species is in every respect similar to those of *intestinalis*, and they are laid, one at a time on a hair and in a great variety of situations—high on the shoulders, on the neck, on the sides of the abdomen, on the insides of the hocks, and even on the mane. The female fly, however, seems to prefer the hairs on the inner side of the forelegs to any other site, and here they may be found in large numbers, and as many as 20 eggs may be found attached to a single hair. The larvae, like those of *intestinalis*, normally live in the stomach, and, to a small extent, in the duodenum of the horse and mule.

The method by which the larva of *intestinalis* reaches these organs has been investigated lately by several authors. ROUBAUD has shown that the young larvae of *intestinalis* can burrow into the buccal mucosa of a guinea-pig and pass down parallel to the surface as far as the throat [see this *Bulletin*, 1918, p. 13]; the larvae would, therefore, seem to reach the stomach by penetrating the mucous membrane of the lips, to which they get attached when the horse licks egg-laden hairs. HADWEN and CAMERON [see this *Bulletin*, 1919, p. 21] showed that the larvae were unable to penetrate the skin of the horse. When in Mesopotamia, Patton obtained a number of *bengalensis* larvae by passing a moistened finger along egg-laden hairs, and these were placed on his skin in order to see whether they could penetrate it. After crawling about for more than one hour and making feeble attempts to attach their hooks to the skin, the larvae seemed to make no progress. Under normal conditions, therefore, they do not penetrate the skin of their host, even although they are able to hatch out from eggs without either the aid of friction or moisture, and there seems little doubt that they gain access to the alimentary tract by way of the mouth. It is not yet definitely settled whether they pass down the tract by their own exertions, are swallowed with food, or whether they penetrate the mucous membrane of the mouth, and then make their way to the neighbourhood of the stomach, to reach the interior of the cavity later. Patton believes that many are swallowed accidentally with food, and that some may produce the so-called "creeping myiasis" as they pass along in the tissues to the stomach. In Mesopotamia the adult insects are seen in March and April, and again

in August and September ; they are very common during these months, and may be seen laying their eggs on horses and mules during the hottest part of the day. The larval stage is passed inside the horse during the winter months, from about the end of October and the beginning of November until March, and again from April to about the middle of August. As is well known, the adults do not feed, as their mouth parts are atrophied.

Gastrophilus nasalis L.—A medium-sized dark species, thickly covered with rufous and light hairs. The eggs of this species, unlike those of *bengalensis*, are laid on the hair close to the skin, and they are deposited one at a time on the hairs between the rami of the jaws. It was noted that when *nasalis* was ovipositing, the animal kept jerking its head up as if to drive away the momentary attack of the fly. This movement was so characteristic, that when one horse among many others was behaving in this way, it was certain that a specimen of *nasalis* was ovipositing on the hairs between its jaws. On closer observation it was noted that the fly approached the horse by darting between its legs and under the abdomen, and appeared to strike it between the jaws. An egg was always found after each time a fly was observed behaving in this way. It is extremely difficult to catch the fly, as its movements are so rapid that one only sees a dark object passing up the abdomen to the jaws to disappear as rapidly. The eggs do not appear to be inserted into the skin. The eggs of *intestinalis*, as is well known, require friction in order to enable the larvae to spring off the opercula, and this is always available when a horse licks egg-laden hairs. With *nasalis*, however, this never happens owing to the peculiar situation in which eggs are laid, and the larvae must reach the alimentary tract by their own exertions. HADWEN and CAMERON found that 51 per cent. of the eggs hatched without any artificial aid, and at the time the larvae were hatching out, they noticed numerous small scabby areas in the intra-maxillary region of horses, and the authors suggest that these areas were produced as a result of the larvae burrowing under the skin. In this connection it is interesting to note that CARPENTER and others have conclusively proved that the larvae of the cattle warble flies only reach the tissues of their host by penetrating the skin immediately adjacent to the egg. The adults of *nasalis* are seen at the same time as those of *bengalensis*, but not nearly in such large numbers. There are apparently two broods during the year.

The presence of *bengalensis*, as also happens with *intestinalis*, may cause a horse to become restive, and in some cases may lead to a stampede, especially with timid animals, and those unaccustomed to the flies, although, as a rule, the animal is not more irritated than by the bites of Stomoxys or tabanids. The presence of the throat bot (*G. nasalis*) is always resented, and this seems to be due to its method of attack. One female *nasalis* will annoy an animal far more than a dozen *bengalensis*, and the cumulative effect of a number of these flies leads to irritation, worry, loss of flesh, and mechanical injuries due to rubbing or falls. It is interesting to note in connection with the recent descriptions in the literature with regard to the probable connection between bots and infectious anaemia of horses, that Patton did not see or hear of a case of this disease in Mesopotamia.

With regard to control, good grooming and cleanliness obviously are the most beneficial means. It is not anticipated that the various repellents that can be used are of any value. Care should be taken

to clip away all egg-laden hairs. If this is done thoroughly and carefully every afternoon during the fly season, the chances of infection will be reduced to a minimum. Further, all mature larvae should be collected and dropped into the incinerator and destroyed. The heavily infested Arab horses should not be allowed near horse and mule lines. In the case of *nasalis*, however, it may be advisable to use some mechanical protection, and a very good one has been described by HADWEN and CAMERON. A piece of canvas is attached to the posterior margin of the nose-band, and posteriorly to the rings of the neck-strap, so that it fits closely over the lower jaws, protects the intramaxillary space, and completely prevents the fly from ovipositing.

CAMEL AND DROMEDARY BOTS.

Cephalopsis titillator Clark (*Cephalomyia maculata* Weid.). A rather small dumpy fly with a mahogany-coloured thorax and a silvery abdomen marked with black spots and streaks. This fly is larviparous in habit and not oviparous as is generally supposed, the larvae being deposited just inside the nasal orifices. The female fly, when about to larviposit, hovers over the nose of the dromedary and then darts at the nasal orifices, depositing one or more larvae at a time. The young larvae apparently crawl up the nostrils by their own exertions to the nasopharynx, where they remain until they are mature. Patton examined the nasopharynx of many dead dromedaries, and the moment the larvae were exposed, they detached themselves and made violent attempts to escape. The mature larva measures about 32–34 mm., is markedly cylindrical in form, and is strongly convex dorsally. Each segment, except the last three, is armed with six large cone-shaped spines on its dorsal surface, three lateral spines, and four on the ventral surface.

The fly is extremely common in Mesopotamia and there are two broods during the year. The larvae of the early brood begin to leave the nasal cavities of the dromedary about the middle of March and continue to do so for three weeks. Larvae collected by the author on March 22nd 1917, pupated on the 23rd to the 27th, and flies began to hatch out on April 10th. The flies were seen depositing their larvae about the middle of April and continued to do so for about a month. These larvae began to leave the nasal cavities about the middle of August and the flies reappeared early in September. These flies again began to deposit their larvae about the middle of September.

It was quite common to see 40 to 50 flies, both males and females, around a dromedary. The movements of the female when she is about to larviposit, sets up considerable irritation and causes the dromedary to sneeze and snort violently. The presence of the flies, however, in no way disturbs the animal.

The mature larvae always left the nasopharynx and began to crawl down the nostrils when the animals were having their evening meal about 5 p.m. The dromedaries fed in long lines on both sides of an earthen trough in which the food was placed. Every now and then an animal would be seen to get restless, stop feeding, and start sneezing and snorting. A more violent sneeze always meant that a larva had been ejected, and it was only necessary to get up to the animal and examine the trough to find it. Many of the larvae were seen crawling out of the nostrils and dropping to the ground. Large numbers of larvae and puparia could be collected from the earth and crevices in the trough wall in dromedary lines during the season.

AUSTEN states that the specimens of this fly taken from the camel have more infuscated wings than those of the dromedary species.

THE SHEEP BOT.

Oestrus ovis L. A medium-sized dark-grey oestrid with white and dark reflections on the abdomen. Very little is known regarding the life history of this fly and there is considerable doubt as to whether the species is oviparous or larviparous, although it is found wherever there are sheep in all parts of the world. Patton expresses no doubt but that in India and Mesopotamia the fly is larviparous, and he has always been able to recover the larva by dissecting the female fly. It would, therefore, appear that the larvae are deposited just inside the nose when the female fly hovers over and strikes at the nostrils. A full description is given of the larval stages, and the mature larva. The fly appears to have two broods in Mesopotamia corresponding with those of the dromedary bot. It is very probable, however, that the fly goes through its life-history much more rapidly in the hot weather, because it is quite common to find fully developed larvae and immature ones at the same time in the nasal passages of the sheep. This was not seen during the winter months. Owing to the protective coloration of the fly it is difficult to find it, yet judging from the large number of larvae seen in the nasal passages of sheep it must be extremely common, for not a single sheep was found to be free from them.

The larva of the dromedary bot does not appear to interfere in any way with the health of the animal, but an examination of the nasopharynx of a large number of dromedaries, however, showed that the larvae set up considerable inflammatory changes, especially when they were present in large numbers. It would be quite easy to devise some mechanical contrivance which could be placed over the nostrils to prevent larvipositing, and collect and destroy the larvae. This would materially lessen the number of flies.

The sheep bot causes, as is well known elsewhere, a purulent discharge from the nostrils; later the sheep may fall and roll on the ground, with clenched jaws, rigid neck, eyes prominent, and death may follow. In the majority of infected sheep, however, a copious nasal discharge is the only sympton resulting from the presence of the larvae. In a country like Mesopotamia where sheep are raised in large numbers, one would think that many of the animals would succumb to the heavy infection, but this is not the case. The Arab takes no precautions to prevent his animals becoming infected and no means can be suggested for controlling the pest.

SOWERBY (M. H.). **Cutaneous Oestriasis in the Dog.**—*Vet. Jl.* 1921. April. Vol. 77. No. 4. pp. 143–144.

In this short note the author describes the case of a dog that was admitted into the hospital of the Bombay Veterinary College suffering from a wound on its scrotum. Seven days after admission a swelling appeared on another part of the scrotum, and in about a week an abscess formed and two or three dead larvae were found in the evacuated pus. At irregular intervals four more like abscesses formed, three on the inside of the right thigh and one on the abdomen. The larvae were about 15 mm. long, composed of 12 segments, and were probably larvae of *Dermatobia cyaniventris*.

GUPTA (M. C.). **Internal Parasites in Elephants.**—*Vet. Jl.* 1921. Jan. Vol. 77. No. 1. pp. 25–28.

In India, diseases due to internal parasites are about the most important among elephants, causing sometimes sudden death of the animals with the presence of an enormous number of worms in the bowels. All elephants are found to harbour a few parasites and a moderate invasion causes no appreciable loss of condition. The first prominent symptom due to the presence of large numbers of one or more species of worms is earth-hunger. The animal eats large quantities of mud, which causes rather violent purging; the dejecta are generally watery and dark-coloured and contain large quantities of worms. The invasion becomes pronounced in animals suffering from some other debilitating disease. When the case becomes subacute in character, signs of digestive disorders of an ill-defined nature become apparent and anaemia becomes very prominent. Debility and emaciation become progressively more marked in chronic cases, the skin becomes dry and broken in parts, and oedematous swelling of the extremities occurs in advanced cases. Constipation followed by diarrhoea sets in and the faeces are occasionally tinged with blood. The mucous membranes are pale, the eyes are dull and present a peculiar look which, to an experienced observer, signifies a worm infestation. In severe cases the condition becomes rapidly worse and the appetite is entirely suppressed. Straining becomes more severe, the faeces become quite fluid and very foetid. The gait becomes staggering, the pulse and temperature are increased at times, the eyes are deeply sunken, and finally the animal can no longer stand up and dies from exhaustion. Sometimes convulsions and paroxysms of colic are manifested. The author gives a rough sketch of the various common parasites found in the elephant.

(1) *Bots.* The bot fly, which is about the size of a bee, and of a dark-greyish colour, is generally most active during the hot season, from the sunny days of June to the beginning of October. As in horses, it deposits its eggs on the fore parts of the body and the ingested eggs hatch in the pharynx, oesophagus, stomach and intestine; mortality due to these parasites is stated to be not uncommon.

(2) *Round worms.* The most common are (*a*) *Ascaris lonchoptera,* together with other Ascarids. The body of *A. lonchoptera* is pinkish-white, head usually slightly curved, and provided with two lateral membranous wings which are broader behind than in front. The part usually infested is the small intestine. (*b*) Hook worms (Uncinaria, Ankylostomes) comprising (i) *Dochmius sangeri* Cobbold and *Uncinaria os papiliatum* Ostertag; (ii) *Bathmostomum sangeri.* These are very common in both Indian and Burmese elephants. Round worm infestation is very prevalent during wet seasons and on low-lying and swampy lands.

(3) *Flat worms* (*Fasciolidae*) comprising both Amphistomes and liver flukes. In 135 post-mortem examinations made by the author, seven elephants were found to be suffering from both these forms of parasites.

Prophylaxis consists in avoiding wet, marshy and suspicious pastures, and segregation of sick animals, together with access to good clean water, and, if possible, to running water. A liberal allowance of salt in the diet is recommended. Santonin and areca nut are claimed to be the most effectual parasiticides. The mixture recommended is powdered areca nut 1 oz., santonin crystals and calomel, of each,

2 drachms. This dose should be repeated in five days. Preparatory to giving the first dose, the elephant is tied up at night and administered 8 oz. Epsom salts at 6 p.m. At 10 o'clock the vermifuge is given, and early next morning a second dose of Epsom salts is given, the animal in the meantime being kept off food. If the animal shows marked wasting in condition, it should be put on a nourishing diet before treatment; otherwise care has to be taken not to use irritant drugs, and calomel alone is recommended in doses of 120th of a grain per lb. body weight. The average weight of an elephant is 6,048 lb. Tonics such as arsenic, iron, nux vomica, and gentian are given during convalescence. Thymol, oil of chenopodium, and turpentine, did not prove successful anthelmintics in elephant practice.

FOLEY (H.). **Microfilaires du chien dans le sud-oranais** (*Mf. immitis*; *Mf. auquieri*, **nov. sp.**). [Microfilariae in the Dog in the South Oran District of Algeria.]—*Ann. Inst. Pasteur.* 1921. Mar. Vol. 35. No. 3. pp. 212–217. With 1 coloured plate.

While investigating dromedary trypanosomiasis (debab) in the above district, the author observed in the blood of dogs used for experimental purposes the presence of two microfilariae, viz.: (1) *Mf. immitis*, and (2) a hitherto undescribed species. According to NEUMANN (1914), five species of microfilariae can be encountered in dogs' blood, viz., the embryos of the following filariae: (1) *Dirofilaria immitis* Leidy; (2) *D. repens* Railliet and Henry; (3) *D. ochmanni* Full.; (4) *Acanthocheilonema reconditum* Grassi; and (5) *A. dracunculoides* Cobb. Ochmann's microfilaria furnishes the only sheathed microfilaria of the dog.

(1) *Mf. immitis*. This widespread microfilaria appeared to be of common occurrence in the South Oran District dogs (it was found in 27 out of 96 dogs from which blood preparations were examined), and it is probably much more common than this proportion (22 per cent.) would indicate. The dogs were native dogs, commonly called kabyles, or crosses of this breed with various imported European breeds, and they lived constantly in the open. None of the infected dogs showed any symptoms attributable to filariasis.

When examined in the fresh state the parasite exhibited twisting and entangling local movements, but only slowly escaped from the field of the microscope. Striation was moderately visible; no sheath, tail markedly attenuated, and movements still fairly active after 48 hours when examined under a cover glass edged with vaseline.

The cephalic extremity bore a probe-shaped process which appeared at first sight to possess most energetic propelling movements. In fact, however, the process is formed of a pointed, slightly arched strip, which is raised like a valve by a sharp trigger-like movement. It is only lowered or shut for brief intervals. In stained smears the organism is usually seen twisted on itself, sometimes turned in spiral fashion and rarely stretched out straight along its whole length. The head is rounded and very slightly attenuated at its extremity. The cuticular striation is scarcely visible at the thin non-nucleated caudal extremity. When stained with weak Giemsa (1 in 40) the nuclei are loosely arranged, oval or rounded, and assume a deep reddish-violet colour. The clear spots are disposed as follows:—

(1) Cephalic area of slightly variable length, ill-defined posteriorly on account of the loose arrangement of the anterior nuclei, the lateral

nuclei being situated at an irregular distance and often in front of the middle ones.

(2) Oblique spot, which is always very clear and occupies almost the whole breadth of the embryo.

(3) V-shaped spot, which usually occupies only a portion of the breadth, and no structural detail is visible in it.

(4) Caudal spot, which appears to be almost as constant as the preceding ones and, in the form of an oval, clear area, occupies two-thirds of the breadth of the body. Beyond this spot the nuclei become arranged almost immediately in the form of a single column; the tail ends in a very fine tapering point deprived of nuclei.

The "central body" does not usually stain with Giemsa, but on rare occasions it is seen in the form of a coarsely granular pinkish-violet thread, slightly swollen at both extremities. In the neighbourhood of this structure the nuclei are scattered apart considerably, and thus the zone corresponding to the central body is made quite visible after staining. As is the rule, the dimensions were variable, depending not only upon the thickness and the more or less rapid desiccation of the smears, the mode of fixation, etc., but also upon the host of the microfilariae examined. In the case of six well-prepared specimens seen in smears fixed in absolute alcohol and stained by haematein or Giemsa, the dimensions were: Total length, 175–253μ; maximum breadth or width, 5–6μ; length of cephalic spot, 7–10μ; distance of cephalic extremity from (*a*) oblique spot, 33–51μ, (*b*) from V-shaped spot, 52–71μ, (*c*) from caudal spot, 141–190μ, (*d*) from central body, 81–96μ; length of clear space corresponding to central body, 24–34μ; length of non-nucleated caudal portion, 14–21μ.

The periodicity of the parasite was studied in the case of a markedly infected dog, but the phenomenon did not appear to be distinct. The organisms varied considerably in number day by day, and they were rare or numerous to an equal degree in smears taken during the day or during the night. Attempts at discovering the adult filariae in the cardiac cavities and large vessels of a dog, the blood of which revealed numerous microfilariae, proved fruitless.

(2) *Mf. auquieri*, n. sp. This organism was found in four dogs out of 63 examined, and in one of these cases it accompanied *Mf. immitis*. When examined in the fresh state it appeared to be a very short organism endowed with only slight local movements, and but rarely and very slowly leaving the field of the microscope; sheathless; striation but slightly visible and seen more particularly on the margins. The anterior extremity was rounded and scarcely tapering, and a slightly serrated circular collar or flange could be distinguished in it, forming a sort of prepuce, which, during its movements of retraction, slightly disclosed the rounded extremity of the head. In the centre of the head could be seen a double papilla, without stilette. After staining with weak Giemsa the organism appeared stumpy, sheathless, rigid in appearance, and usually assumed a stretched out straight appearance with a single curve towards its middle or towards its end, and it showed but rarely along its length one or two folds. The fine striation of the cuticle could only be seen on the margins; the nuclei were compacted and irregular, and occupied the whole length and thickness of the body, and stained an ultramarine blue. The nuclei at the extremity often assumed a reddish tint. The last nucleus did not

quite reach the caudal extremity, which tapered suddenly in a short and very acute point.

The clear spots were disposed as follows:—(*a*) Cephalic area was very short; the foremost nuclei, which were often disposed in longitudinal columns, nearly reaching the extremity of the head; (*b*) oblique spot, constantly present, quite distinct, with parallel borders, and occupying the whole width of the body; (*c*) caudal spot, often absent and always rather indistinct. After staining with Giemsa no central body could be seen, In eight specimens stained with Giemsa the dimensions were: Total length, 58–102μ; maximum width, 6–8μ; length of cephalic spot (in two), 2·5–3μ; distance of cephalic extremity from (*a*) oblique spot, 13·5–22μ, (*b*) caudal spot (in two), 44–78μ; length of non-nucleated caudal extremity (in five), 6–8μ.

This microfilaria appears to be undoubtedly a new species. *Dirofilaria repens* is even larger than *Mf. immitis*, varying, according to RAILLIET and HENRY, from 300–360μ by 6·5–8μ. *Mf. recondita* measures, according to NOE, 216μ by 4·3μ. The embryos of *A. dracunculoides* measure 195–230μ by 5–5·5μ. Ochmann's microfilaria measures, according to FULLEBORN, 320μ, and is sheathed.

Mf. auquieri did not appear to exhibit any distinct periodicity, but perhaps the periodicity of these microfilariæ might have been disturbed by the habits of the native dogs, which sleep at irregular times. During part of the day they are in sleeping condition, and as they are good watchdogs they bark furiously around the tents for many hours during the night.

TURKHUD (D. A.). **Dracontiasis in Animals, with Notes on a Case of Guinea-Worm in a Cobra.**—*Indian Jl. Med. Res.* 1920. April. Vol. 7. No. 4. pp. 727–734. With 2 plates (1 coloured) comprising 3 figs.

Guinea-worm disease has been recorded by a number of investigators in dogs, horses and cattle, and in this article the author first gives an account of the rare cases that have been recorded in India. That the condition is a rare one is evidenced by the fact that during the course of investigations conducted in the Bombay Bacteriological Laboratory, the Director and Staff of the Laboratory visited a number of villages in the Bombay Presidency in which guinea-worm disease was known to be widely prevalent among human beings, but in these excursions they came across no cases showing the presence of the worm in any of the village animals, such as cats, dogs, goats, horses and cattle, although these animals always drank the same water as the inhabitants of the infected villages. The villagers themselves had no knowledge of infection in these animals with guinea-worm.

Dogs. SMYTTAN (1825) and FORBES (1837) recorded the presence of guinea-worm disease in dogs in India, and more recently GAIGER (1910) reported five cases of *Filaria medinensis* in dogs. Two of these were discovered at the Punjab Veterinary College, and the other three at the Veterinary Hospital, Simla, and in all cases, it was stated, the worms were identical with the human parasite, and contained a white fluid in which were the coiled-up embryos. There is also in the Museum of the Madras Veterinary College a specimen of guinea-worm closely resembling the human guinea-worm removed from a dog. In 1917 experiments were conducted at the Parel Laboratory, Bombay,

with a view to producing guinea-worm disease in dogs by feeding them on infected Cyclops, but the experiments proved unsuccessful.

Horses. FORBES (1838) described a case of guinea-worm infection in a country-bred pony at Dharwar in the Bombay Presidency. The worm protruded from a swelling near the right hind fetlock, and, according to this observer, it was examined before and after extraction, and no difference between it and the human Dracunculus could be perceived. CLARKSON (1845) found a guinea-worm in an Australian waler at Kotagherry, on the Nilgiri Hills. COBBOLD (1881) reported infection of a pony at Secunderabad. BATLIWALA (1893) again described infection of an Arab gelding in Burma, and the worm was stated to be very much like the guinea-worm, which is very common in man in Katywar. In 1914 Turkhud received a specimen of guinea-worm extracted by BHAVE from a pony at Thana, in the Bombay Presidency.

Cattle. BLANCHARD (1890) stated that the disease was known in 15th century Arabic medicine to occur among cattle. There are no records showing the existence of the infection among Indian cattle. On the authority of HECKENROTH, it is asserted by BARTET (1909) that the disease is met with among cattle in West Africa.

Wild Animals. The records are very scanty, but a few cases have been described in some of the wild animals of Africa. According to RAILLIET (1889) guinea-worm was recorded by PIOT in a jackal killed in Upper Egypt, and also in an Egyptian wolf. VALENCIENNES (1856) found a number of coiled up guinea-worms in the subcutaneous connective tissues of a hunting leopard from Kordofan, and CAZALBOU (1909) came across similar worms in a monkey. LEIPER (1910) recorded an interesting case of guinea-worm infection in a leopard shot in North-Western Rhodesia, a part of Africa where guinea-worm disease is not known. The worm, which was 45 cm. long and 1·5 mm. broad, was stated to resemble exactly the guinea-worm found in human beings on the West Coast of Africa, and its body was filled with a single uterine tube crowded with embryos corresponding exactly in size and structure with those of the human worm. BROOKE-FOX (E.) (1913) describes what is apparently the only observation of guinea-worm infection among the wild animals of India living in the natural state. The parasite was found in a Chinkara buck shot at Junagadh in Kathiawar. About half a dozen thread-like semi-translucent worms, varying in length from two to five inches, and all alive and vigorous, escaped from the bullet wounds in the skin.

The author refers to two additional cases of the occurrence of the worm in wild animals in captivity: (1) a leopard sent to the Bombay Bacteriological Laboratory from the Victoria Gardens for post-mortem examination about 12 years ago; and (2) from an abscess on the thigh of an Arabian baboon received in 1919 from the Gardens. The worm was entire, 92 cm. long and 1·5 mm. in diameter, and resembled the human guinea-worm in every respect.

Guinea-worm in the Cobra. The case described by the author is unique, as this is the first account of the occurrence of the worm in a cold-blooded animal. The snake had been purchased by the Laboratory for venom production, and seven months after purchase a loop of worm about 1 mm. thick and 4 cm. long was noticed to be protruding from a slight swelling on the head. This piece was found to show a central uterine tube containing active embryos somewhat smaller than but otherwise resembling those of the human guinea-worm.

The cobra was subsequently killed. A small quantity of whitish fluid was found to exude from the opening in the swelling, and it contained a large number of embryos, which were sluggish at first, but soon became quite active, and swam about in water like the embryos of a human guinea-worm. The guinea-worm was found to be situated between the muscles on the back parallel to and along the right side of the spine. The anterior extremity was missing, and when about 12 cm. of the worm had been dissected out it was found to terminate in a short curved tail. It was 1 mm. in breadth, but in all other respects resembled the human guinea-worm. The embryos were much smaller than those of the human guinea-worm; length 0·3 mm., breadth at broadest part 15–20 μ.

Some of the embryos were added to water containing Cyclops, while a few were allowed to remain in plain water at room temperature. The latter, however, were all found dead after three days. Examination of the Cyclops 12 hours afterwards showed that 10 out of 12 became infected. In five days 15 out of 42 examined were infected. In a fortnight's time 150 infected Cyclops were withdrawn. The embryos measured at this time 0·6 mm. long by 30 μ broad. The Cyclops were divided into six lots of 25 each, and six healthy cobras were fed each with a lot of 25. Three healthy cobras were similarly fed out on 25 Cyclops infected with embryos of the human guinea-worm. All these cobras died within the subsequent 12 months, but only two showed any abnormal post-mortem appearances, viz.: (1) Died 2½ months after feeding. A worm about 2 cm. long and 1 mm. broad was found subcutaneously just under the abdominal scales, midway between the head and the anal aperture. The worm was flat, transversely striated, and showed contractile and relaxing movements. This cobra had been fed with Cyclops that received the embryos of the cobra guinea-worm. (2) Died ten months after feeding. Five worms were found within it, all flat, transversely striated, and also showed alternate relaxing and contractile movements. Four of the worms were small, about 2 cm. in length, and situated in the peritoneal cavity. One worm was situated just underneath the skin. This cobra had been fed upon Cyclops infected with embryos from a human guinea-worm.

As so little is known about the development of *Dracunculus medinensis* within the body of its definitive host, it could not be stated with certainty that these represented undeveloped forms of a guinea-worm.

BACTERIAL DISEASES.

Dodd (S.). **The Etiology of Black Disease.**— *Jl. Comp. Path. & Therap.* 1921. Mar. 31. Vol. 34. No. 1. pp. 1–26. With 6 figs.

A reference to this author's previous interesting studies on this disease have already been made in this *Bulletin* [1918, Vol. 6, No. 3, p. 190], and although the disease under consideration is not of particular importance from the point of view of tropical work, but is, on the other hand, a common and serious condition in temperate countries, the investigations threw considerable light on certain aspects of ovine pathology. The author had already proved that the organisms incriminated by former workers as the causal agents of braxy-like

diseases could be attributed entirely to post-mortem or agonal invasion, for when, after diligent search, subjects were obtained while they were still showing symptoms and a bacteriological examination was made of their tissues and body fluids, the findings were almost invariably negative.

In this paper Dodd describes the post-mortem changes observable in sheep slaughtered when they were found to be ailing or when examined just immediately after death. The early lesions of the disease were definitely traced to the liver, but all the livers, moreover, showed evidence of recent fluke invasion. The organ almost invariably showed one or more necrotic foci, greyish or dirty yellowish-white in colour, firm, odourless, varying from a quarter to two inches in diameter, usually circular, but occasionally elongated. The edges were irregular, but sharply circumscribed. These foci could be found in any part of the liver substance, and not infrequently circular haemorrhagic areas up to one inch in diameter could also be met with in the liver. Congestion of the small intestine was also observed, and it was most pronounced in the duodenum. In the liver lesions the presence of a Gram-fast anaerobic bacillus in pure culture was demonstrated. Microscopically the lesion presented the appearance of a coagulative necrosis, surrounded by a broad zone of leucocytes, and immediately within this zone the bacilli were found often in thick felted masses. Occasionally a sporing bacillus with a terminal or sub-terminal spore could be seen. Many of the bacilli were filamentous around the margin, but in the interior they were usually single.

The author now believes that these organisms play a primary rôle in the production of black disease, although in his former communication he was inclined to think that they were secondary invaders, as they were apparently absent from the haemorrhagic areas, which he regarded as the precursors of the necrotic lesions. The evidence, however, shows that these two kinds of lesions have a different pathogenesis, and that the haemorrhagic areas are probably merely the result of early fluke infestation, while the necrotic areas, it would appear, are in all probability the result of a fluke invasion plus a superimposed bacterial invasion.

A short description is given of the morphological and cultural characters of the bacillus, which is quite similar to that of various members of the so-called malignant oedema group. When tested by subcutaneous and intramuscular inoculation into sheep, doses of 0·5 to 1·5 cc. of culture were found to be almost invariably fatal to sheep in from 28 to 78 hours. Doses of 0·1 cc. subcutaneously were usually fatal to guinea-pigs in about 24 hours, while for rabbits the fatal dose was larger, 0·25 to 0·5 cc. Doses of 0·2 cc. injected intramuscularly proved fatal to the fowl. The disease could not be transmitted by feeding, but previous work had likewise shown that the condition could not be transmitted by ingestion of any part of an animal dead from the disease.

The clinical and experimental evidence available regarding the disease shows that it is somehow intimately associated with the prevalence of fluke infestation. Black disease has a seasonal and local distribution corresponding with those conditions most suitable for the propagation of the intermediate host of the flukes. The causal organism of black disease would therefore be a facultative parasite, and the parts most dangerous for sheep would be the springs and moist undrained areas in certain paddocks; the mortality from the

disease is, moreover, well known to be highest during those years in which fluke disease is rampant.

The recent investigations with regard to the method of penetration of flukes into the living animal, via the intestine, peritoneal cavity, and through the liver capsule, and not up the bile duct, would also appear to lend further support to this view.

Experiments also showed that measures undertaken with the object of keeping down fluke disease, such as drainage, simultaneously caused a most marked reduction in the incidence of black disease.

Immunisation could be accomplished in the laboratory by the inoculation of sheep with attenuated cultures, for the organism seems to lose its virulence very rapidly on cultivation, but when tested in the field on a large scale the experiments miscarried inasmuch as a marked reduction in mortality also occurred among the control animals, due to the preventive measures that had also been undertaken.

Black disease is in all probability identical with the braxy-like diseases of Tasmania and Victoria, although the organism claimed to be the cause of the latter is not identical with that isolated from the former. It is also quite probable that black disease is identical with the braxy or bradsot of Europe. But definite information upon this point can only be obtained when the causal organisms are submitted to comparative laboratory tests.

GLOSTER (T. H.) & SHANKS (G.). **Report on an Epizootic Disease among Calves at the Amara Dairy Farm.**— *Indian Jl. Med. Res.* 1919. Oct. Vol. 7. No. 2. pp. 382–397.

In this article the authors give an account of some laboratory investigations carried out upon an organism isolated from a disease, not unlike white scour, affecting young calves from one to three weeks old at the Dairy Farm, Amara, Mesopotamia.

The disease was not associated with any very definite symptoms, and in the majority of cases the illness was not recognised until a few hours before the death of the animal. The organism isolated from the lesions was a coliform organism belonging to the Salmonella group [which is held to include *B. paratyphosus* (*B*), *B. aertrycke* (or *suipestifer*) and *B. enteritidis* Gaertner, together also with *B. paratyphosus* (*C*), isolated from human cases of enteric fever, liver abscess, etc., in Mesopotamia]. Cross-agglutination and absorption tests, however, indicated that the organism was different from the *B. paratyphosus* (*B*). and *B. paratyphosus* (*C*), and also possibly from Gaertner's bacillus. It most closely resembled the *suipestifer* bacillus. The bacillus was isolated from the blood, bile, organs, mesenteric glands, and intestinal ulcers of calves that had died from the disease. It was pathogenic for rabbits and guinea-pigs and for calves when given intravenously. The results of agglutination tests carried out with the sera of healthy calves and dams showed, it is stated, that the infection was widespread among the cattle at the Dairy Farm, and that many infected calves recovered. No proof was obtained that the disease was due to a filterable virus, as inoculation of filtered spleen material and blood gave no result upon inoculation into a guinea-pig and rabbit and to a calf, respectively. [From the standpoint of the veterinary investigator, this piece of work appears to have been incompletely carried out.—ED.]

MYCOTIC DISEASES.

NÈGRE (L.) & BOQUET (A.). **Sur le traitement spécifique de la lymphangite épizootique par les cultures stérilisées de cryptocoques.** [Specific Treatment of Epizootic Lymphangitis by Means of Sterilised Cultures of Cryptococci.]—*Bull. Soc. Path. Exot.* 1920. Dec. 8. Vol. 13. No. 10. pp. 777–779.

In a previous note the authors described treatment by the above method (this *Bulletin*, 1918, Vol. 6, No. 3, p. 179), but the results, although very encouraging, were obtained with a small number of horses and had not then been confirmed in current practice. The authors placed at the disposal of several practitioners in France, Northern Africa, and Italy a vaccine which was prepared as follows :— The organisms obtained from cultures four to six weeks old, grown in the incubator at 35° C. on Sabouraud's medium, are collected by means of a spatula, crushed in a dry mortar and emulsified in 0·5 per cent. carbolic acid, so that each cubic centimetre of the liquid contains 5 mg. of culture. The mixture is then heated in a water-bath for $1\frac{3}{4}$ hours at 65° C.

The injections are performed once weekly under the skin of the neck, in increasing doses of 1, 2, 3, 4, and 5 cc. These are repeated until recovery takes place, but the doses given never exceed 5 cc.

During the first four weeks one sometimes observes a slight transient aggravation of the lesions following upon the injections. This need not give rise to any alarm, but the treatment should be continued as indicated. However, if the reactions are too well marked or too prolonged (4–7 days) the dose injected should be diminished in size.

Over 150 horses were injected in this manner, and these animals were affected with more or less severe forms of the disease, affecting the fore and hind limbs, the abdominal wall, breast, neck and withers, or generalised lymphangitis affecting various parts of the body and mucous membranes. Information was obtained only with regard to 86 of these animals. The number cured was 71, or 81 per cent.; among the failures are included all cases treated during the last stage of the disease, when the specific lesions were contaminated with secondary bacterial invaders, and all cases in which treatment was interrupted for various reasons.

The majority of the veterinary surgeons observed likewise that during the first period of treatment the lesions remained stationary or became aggravated. It was only towards the fourth week that the first signs of improvement became manifest by decreasing suppuration, progressive cicatrisation of opened lesions, and absorption of corded lymphatics and nodules. A few animals, including some severely infected ones, were cured after four injections, but in the majority of cases from eight to ten weekly injections were necessary. The average length of treatment was estimated at two months. One mild and localised relapse in the form of three small nodules was observed. All the practitioners who employed the treatment appeared to be satisfied with the results and the facility with which the treatment could be applied. The animals may remain at work, except perhaps on the day following the injection, when they sometimes show a slight rise in temperature. The sterile abscesses which are produced as the result of the injections become rapidly cicatrised and are not followed by any complication.

The results obtained, in particular by Vet.-Major FORGEOT at the Veterinary Research Laboratory of the French War Ministry, were of such an encouraging nature that the Military Authorities have decided to apply the treatment to all horses affected with the disease in the French Army.

DESCAZEAUX. **Sur la presence de cryptocoques dans le tube digestif d'un cheval lymphangiteux.** [The Presence of Cryptococci in the Digestive Tract of a Horse Affected with Epizootic Lymphangitis.] —*Bull. Soc. Path. Exot.* 1921. Feb. 9. Vol. 14. No. 2. pp. 66–69.

This horse, which died as the result of some digestive disorder, had been treated for epizootic lymphangitis with lesions on each side of the withers and was on the road to recovery. On post-mortem the presence of digestive trouble was confirmed and a search was made throughout the body for cryptococci. They were numerous in the enlarged left prescapular gland, and were also present in the right gland which had previously been enlarged. The axillary gland also showed a few of the organisms. In the thoracic and abdominal cavities no sign of any lesion due to epizootic lymphangitis was seen. The stomach and intestine showed no specific alteration and the mesenteric glands appeared healthy. However, smears made from scrapings of the mucous membrane of the stomach and intestine were found to contain numerous cryptococci, most of them of the usual shape, but some were large and rounded, and differed from those usually found in the pus and external lesions inasmuch as they were less refractile and contained numerous granules. The parasites were very numerous in the stomach, numerous along the whole length of the small intestine, and rare in the large intestine. In the stomach a tumour about as large as a marble was found at the junction of the left and right portions, apparently caused by Spiroptera. On puncture a milky fluid escaped, which proved to be a very rich emulsion of cryptococci, and two adult male and five larval Habronema worms were also found.

Sections were made for histological purposes and stained by Claudius. The Spiroptera tumour appeared to be of recent origin and composed of inflammatory tissue infiltrated with leucocytes and containing very numerous cryptococci. The internal portion seemed to be formed of an actual mass of cryptococci, together with a large amount of debris of the parasites. The middle zone showed an abundant infiltration with leucocytes and contained numerous cryptococci. The free-lying cryptococci were massed together in groups of 10 to 30 parasites forming large rounded masses. Giant cells containing numerous parasites were also seen. The external zone was formed by the gastric mucous membrane. The epithelial cells showed no changes, but between the cells and the lymphatic spaces there were very numerous cryptococci. Sections of the stomach wall showed large numbers of parasites in the submucous lymphatic spaces, but no cellular lesions. In the intestine the lesions were similar, but the cryptococci were less numerous. In certain places the mucous membrane showed actual ulcers in which the parasites could be found. The organisms were sometimes numerous in the region of the solitary follicles. In the submucous coat small capillary haemorrhages could be found and cryptoccoci were seen in the vacuoles.

The parasites observed in the sections showed the usual features; large rounded forms were seen and numerous budding forms, together

with small round forms from 1 to 2 μ in diameter. If the decolorisation was pushed too far, the parasites appeared to be refractile and possessed a double contoured envelope.

REID (H. A.). **Notes on Certain Cases of Dermatomycosis of Cattle.** —*Vet. Jl.* 1921. Jan. Vol. 77. No. 1. pp. 21–23.

Reid describes briefly a mycotic skin disease of cattle in New Zealand presenting points of considerable resemblance with a similar condition which has recently been described by authors in Southern Central Africa [see this *Bulletin*, 1920, Vol. 8, No. 3, p. 232, HORNBY, Contagious Impetigo of Cattle in Northern Rhodesia; VAN SACEGHEM, similar condition in the Belgian Congo, this *Bulletin*, 1917, Vol. 5, No. 2, p. 108; see also preceding number of this *Bulletin*, p. 35, for description of the condition known as Saria in the Lake Nyasa District by CURSON.]

The cattle were of the Red Devon breed and were kept under open conditions in a large station. The disease ran a very chronic course, and appeared in some animals to commence on the loins and then spread to their sides, abdomen and legs. The epidermis was greatly thickened and cornefied, and it was fairly easily detached in some places and fairly adherent to the subjacent tissues in others. Removal of the scab exposed a moist, congested surface covered with a sticky greyish exudate with a sour musty odour. The condition did not appear to cause any considerable amount of irritation, the animals did not respond to scratching, and removal of the scabs caused evident pain. The affection caused slight loss of general condition and some degree of fever, up to 103·4° F. One animal, a heifer, presented the condition in such an advanced form that nearly the whole body was covered with thick, greyish scabs, which in some places had become heaped up and projected $\frac{1}{2}$ to 1 inch above the body surface. The heifer was destroyed, as it was in poor condition and exhaled a putrid odour.

Microscopic examination of smears made from the exudate showed the presence of mycelial masses of a fungus, together with some cocci. The necrosis bacillus could not be found. Experimental transmission was then attempted by rubbing some of the scabby material on to the skin of calves with or without previous scarification. In five days the skin became hyperaemic and on palpation the commencing eruption could be distinctly felt. Two days later the skin was rough and covered with firmly adherent scabs; the hair over the inoculated surfaces had not been shaved. In ten days the typical lesions had become formed; a sour, musty odour was noticeable. The skin felt greasy and was tender and painful to the touch. The scabs could now be detached and, on microscopic examination, the same appearance was revealed as in the original cases, except that the mould was not quite so luxuriant. The mould was invariably associated with cocci. Rabbits, guinea-pigs and fowls proved refractory to inoculation.

Cultures on ordinary laboratory media from the material collected from the skin gave rise to a profuse growth of staphylococci. The most satisfactory method for cultivating the mould consisted in enclosing a portion of the scab between two moist chamber slides held together along the edges with wax. These were then placed in a sterile Petri dish lined with damp blotting paper and incubated in the dark at room temperature. Seven days later the mould had commenced to form a conspicuous growth along the edges of the scab.

This growth was sub-cultured into acid agar and gelatine plates. The agar plates, incubated at 37° C., showed after 12 hours the growth of a white mould consisting of a mycelium of branching septate hyphae, showing chlamydospores. Attempts to infect cattle with pure cultures of the mould alone or with the staphylococcus did not succeed. The weather was cold and rather wet at the time, and it is supposed that these conditions might be disadvantageous to artificial inoculations with moulds. The mould appears to the author to simulate to some extent *Epidermophyton gallinae* Megnin, a fungus which causes favus of birds and is inoculable to rabbits, mice and the human subject, but not to rats.

The disease set up by the artificial inoculation of cattle with material from the original cases ran a benign course, and cleared up without treatment in from four to six weeks. Treatment of longstanding cases with 2½ per cent. creolin proved effectual after preliminary washing with soap and warm water. The disease did not seem to show any marked tendency to spread among the herd.

DISEASES DUE TO FILTERABLE VIRUSES.

VELU (H.). **La fièvre aphteuse au Maroc. L'importance de la médication toni-cardiaque.** [Foot-and-mouth Disease in Morocco, Importance of Administering Cardiac Tonics in Treatment.]—*Bull. Soc. Path. Exot.* 1920. Nov. Vol. 13. No. 9. pp. 726–729.

Foot-and-mouth disease has long been recognised in Morocco, where it is known to the natives as "Bou Jder" or "Bou Jedri"—terms which include all eruptive contagious affections, such as sheep-pox, small-pox, cow-pox, and fowl-pox. Among ruminants the condition generally runs a mild course, but from time to time outbreaks of exceptional severity occur. Such outbreaks were observed about 20 years ago, again in 1913, and in 1920. The more severe forms of the disease occur in cattle subjected to much fatigue or bad hygiene, and in pigs herded together before or during shipment. In these conditions deaths are not rare and convalescence is of long duration. In the 1920 outbreak the milk production of the herds of Spanish goats at Casablanca diminished considerably. Young sucking animals were found to be much more susceptible than were adults, for calves and lambs succumbed in large numbers to the septicaemic forms of the disease. In the mild forms usually observed in adults discrete lesions are to be found above the claws, which cause very slight lameness, lasting three or four days at most, while typical lesions on the lips and tongue, which cause a little difficulty in swallowing for two or three days, are also seen. Very rarely, lesions are found on the udder. Buccal lesions were seen on two gazelles. The disease never lasts longer than a week, and natives who do not also carry on pig breeding attach no importance to the affection.

The virus appears to be endowed with a high degree of pathogenicity for the pig. Adult animals exhibit only localised lesions on the mouth, mammary glands or feet, usually of a mild character. In 1913 the foot lesions appeared to be more intense, because the animals were kept entirely at grass during the course of the outbreak (May–October). In young pigs, on the other hand, the disease became

manifested under various forms, which were often septicaemic and of exceptional severity. Four main forms were recognised, viz., (*a*) buccal form, with more or less confluent vesicles on the lips, tongue and gums; (*b*) the foot form, with congestion of the coronary region, interdigital vesicles, and necrosis, and very often sloughing of the claws, in about 40 per cent. of cases; (*c*) alimentary form, with severe general symptoms and typical lesions of gastro-enteritis; (*d*) pulmonary form, with diffuse bronchitis and pneumonic centres.

In all the severe outbreaks the high mortality has to be attributed to the cardiac lesions, and death supervenes very often from cardiac syncope without preliminary signs. Cases of sudden death occur in animals during the hotter periods of the day, when they are made to move, and sometimes animals in very good condition with mild or healing lesions succumb in this manner. Post-mortem, myocarditis is always marked. Treatment of the local lesions in young pigs therefore becomes a secondary consideration, and cardiac tonics are more indicated. Velu used camphorated oil to this end and the results were very encouraging. In one large establishment containing over 10,000 pigs this treatment was applied to 200 young pigs. Mortality ceased in two days, although it had amounted to four or five per day prior to the injections.

ZELLER (H.). **Über Pocken bei Ziegen Sudwestafrikas.** [South-West African Goat Pox.]—*Arbeiten a. d. Reichsgesundheitsamte.* 1920. Oct. Vol. 52. No. 3. pp. 501–537. With 7 figs. and 2 tables.*

This research was conceived on the receipt from a veterinary officer in (then) German South-West Africa of scab material preserved in 50 per cent. glycerine. A short accompanying descriptive note stated that goats in the sender's district showed black warty growths round the mouth and nose, which on removal left a patch of raw underlying tissue. Kids were stated to be mostly affected, but sheep contracted the affection also. The course of the disease was usually favourable.

The material, soaked and softened by the glycerine, was obviously a conglomeration of scabs, hair and dirt, of macerated consistency and brownish colour.

Microscopic and cultural examination revealed the presence of many organisms, mainly *B. subtilis* and *Staphylococcus pyogenes albus.* Neither of these were considered to be causal, but cultures both of the whole material and of the isolated coccus were inoculated by scarification on to an adult goat and a kid. Beyond the development of a few pustules, which soon disappeared, no result was obtained.

Inoculation by scarification of the original material on the muzzles of goats and kids reproduced the disease as reported by the sender. The course in detail was as follows:—

On the second or third day, earlier in kids than in adults, pronounced redness and swelling appeared, which increased during the following day or two. Now a yellowish glairy fluid was secreted, which rapidly hardened to form a yellowish-brown scab. The lesions tended to spread somewhat, reaching a maximum at the 8th to the 12th day. Where the scabs cracked there was further oozing of yellowish fluid, which again dried as usual. Meanwhile, at about the 5th day in kids, or a day or two later in adults, small red spots appeared at the

* Abstracted by Mr. S. C. J. Bennett, B.Sc., M.R.C.V.S.

commissures of the lips, about the junction of the skin and mucous membrane. These developed into papules up to the size of a pea, and if pulled off at this stage a bleeding, slightly suppurating, granulating surface presented itself; if left alone scabs eventually formed, or in some cases pustules followed by scabs.

From the 12th to 16th day, earlier in adults, the lesions began to clear up, the scabs dropping off, leaving a complete new skin with young hair. It is to be specially noted that in no case was necrosis observed, but in the case of pigmented lips the pigment was not reproduced, so that the lips of recovered animals were blotched with white areas.

At about the same time that the papules appeared at the commissures of the lips, or about a day later, small, sharply circumscribed, inflammatory areas developed on the buccal mucous membrane, accompanied by increased salivation. These started as pinhead papules and developed into raised plaques up to a centimetre in diameter. Their surface turned from white to yellowish, becoming eventually shed to leave a sharply defined, meagrely suppurating defect, which healed completely in five to eight days, leaving no scar. In some cases, before the ulcers healed, papillomatous outgrowths of considerable size developed, but the result was always healing without a scar. In addition to the foregoing, some subjects showed, particularly on the tongue and gums of the lower jaw, cord-like proliferations of the mucous membrane, either plain or dividing, but these, as all other lesions, eventually healed. On the mucous membrane, as on the skin of the lips, no sign of necrosis was ever observed, and after recovery no scar remained.

As a result of inoculation on the muzzle, some goats and kids developed cutaneous lesions, mainly about the head and neck, but not confined to these regions. The lesions were very similar to those on the skin of the lips, and on healing no scars remained, with one exception; this was a she-goat suckling a kid, and repeated pulling off of the scabs caused a few small scars to persist. However, in no case did any suckling female develop signs of mastitis.

Systemically, kids became fevered, would not suck, and lost condition, but never had diarrhoea. The adults, on the other hand, presented no systemic symptoms.

On the whole the kids were the more severely affected; symptoms set in earlier after inoculation, the course was more acute and they lost more condition, although no deaths occurred. Both in kids and adults the period from inoculation to complete recovery was three and a half to four weeks.

Further inoculation experiments, either with or without scarification, proved the infectivity of the material to other parts of the body—skin, lips of the vulva, lower surface of the tail, etc. Instillation of material into the eye was followed only by a very mild conjunctivitis, which soon cleared up, leaving no trace. Natural infection by contact was also observed.

Test inoculations as to transmissibility to other domestic animals failed to reproduce the disease in horses, dogs or pigs. A transient local lesion following scarification appeared in two heifers out of four in which transmission was attempted. Sheep and lambs proved to become affected to the same degree as goats and kids. Small laboratory animals were completely unresponsive, no lesion being produced on the cornea of rabbits even after scarification.

That the virus is very contagious was proved by keeping sound animals in contact with infected ones; they invariably became infected and, moreover, the disease was found to spread with equal facility from sheep to goats, and conversely. The disease even spread to some animals at a distance and to some at grass. Convalescents, however, were noticed to be harmless. In spite of this observed extreme contagiosity, attempts to cause infection with blood, milk, saliva or urine of infected animals failed.

Microscopic examination of the blood, either fresh, in hanging drop direct, or by dark ground illumination, or of smears stained in various ways, gave no clue as to the nature of the cause, and showed no specific alterations which could help from a diagnostic standpoint. Similar examinations of scabs from the local lesions, as in the case of the original material, showed a variety of non-specific bacteria only. In addition, all attempts at cultivation, whether from blood or organs, failed; moreover, no macroscopic lesions attributable to the disease were to be found in any part of the body; it is particularly to be noted that the presence of a true vesicle, considered to be a classical stage of pox, was never observed, the earliest stage always being a papule or pustule.

Histological examination of skin and mouth lesions showed nothing of importance. The ordinary phenomena of inflammation and abscess formation, together with some fibroblastic activity and granulation, were the only alterations observed. Particular care was exercised in examining sections of cornea from rabbits infected in this position by scarification. The only information so derived was that keratitis developed approximately in proportion to the severity of the scarification; in no case could the presence of intracellular bodies (*Guarnieri bodies*) be demonstrated.

The presence of immune bodies in the blood of infected animals was demonstrated by the precipitation test. An extract of scab material (filtered) gave positive results with the serum of infected animals, and not with that of sound animals. A control extract was used consisting of an extract similarly prepared from the skin of the lips and nose of healthy animals. Incidentally, it was found that positive results were only to be obtained with a strong (10 per cent.) scab extract; moreover, boiling of this extract destroyed its usefulness. Unfortunately, shortage of material and other circumstances prevented the author from studying this question on a more comprehensive scale.

Several experiments were performed to ascertain the viability of the virus. As already noted, the material sent from South-West Africa in 50 per cent. glycerine was alive at the end of three months. After the European war, during which period these experiments were left in abeyance, the glycerined material was found to be avirulent, *i.e.*, after $4\frac{3}{4}$ years. Dry scab material, left in ordinary plugged tubes for the same period, was found to be still virulent, although at a first inoculation only a mild form of disease was induced. Scab extract, once brought to the boil over a flame, was inactivated completely, and heating at 70°–80° for one hour had the same effect; one hour at 60° reduced its vitality considerably. Putrefaction at room temperature had little effect, but in an incubator at 37° C. the virulence diminished gradually, to be entirely lost after 53 days. In an ice chest, 90 days was the period required. Short exposure to chemical disinfectants has little effect; for example, 5 per cent. solutions of creolin, antiformin

and carbolic acid, or 1–1,000 corrosive sublimate did not kill it in five minutes. A 1–1,000 solution of sublimate was found to kill it in 24 hours.

The question of filtrability was unfortunately not definitely settled. A glycerine extract filtered through asbestos and centrifuged showed the clear supernatant liquor to be infective, and filtration through Berkefeld filters of varying densities passed a fluid which proved infective in one-third of animals tested. The results were too equivocal to warrant a definite conclusion, and, unfortunately, the author was unable to repeat the experiments more extensively.

Immunisation experiments afforded some useful information. Recovered animals had a strong, durable immunity. The longest period tested was seven months, but immunity against experimental inoculation was still absolute. Blood inoculation, either with serum or defibrinated blood of affected or recovered animals, afforded no immunity whatsoever, and likewise the killed virus in scab material had no effect. On the contrary, subcutaneous injection of a glycerine extract of virulent material produced a strong immunity. This resistance developed slowly, as it would not prevent infection after a week, but was absolutely protective after three weeks. Intraperitoneal injection of similar material induced no immunity.

In conclusion, some discussion is raised as to the actual nature of the condition under consideration. On the whole it appears to be pox, but some of the recognised, or most postulated, features are absent. In the first place no true vesicular stage was observed, and, further, no intracellular enclosed bodies were found, either in the lesions of the affected animals or in the cornea of inoculated rabbits. These discrepancies, if such they be, are not to be too seriously considered, for the variolae of animals, excepting those of cattle and sheep, are almost unexplored fields. Again, it may be that there is no such condition as true goat-pox; it may be that it is only a modified or atypical form of some other variola—cow-pox or small-pox. It is known that atypical forms are found on the natural subject of a true variola; might not the lack of certain classical features be so explained? Reports of other observers, particularly in Africa, are mentioned in which conditions are described not differing very much from the one under consideration. It appears that a good deal more work on the subject is indicated to co-ordinate the information to hand and, perhaps, to attempt some cross-immunological differentiation.

Schern (K.). Mavrides (N.) & Major (A.). **Über Rinderpest (Vierte Mitteilung). Über die Wirkung des von anatolischen und podolischen gewonnenen Rinderpestserums für Friesländer Rinder nebst Beobachtungen über** *Piroplasma parvum* **(Ostküstenfieber) in der Türkei.** [Rinderpest (4th Communication). Concerning the Action of Rinderpest Serum obtained from Anatolian and Podolian Cattle on Friesians, together with some Observations on *P. parvum* (*Theileria parva*—East Coast Fever) in Turkey.] —*Zeitschr. f. Infektionskran. d. Haustiere.* 1920. July. Vol. 21. No 1. pp. 82–96.*

The primary object of this research was to ascertain the immunising power of rinderpest serum obtained from hyperimmunised cattle of

* Abstracted by Mr. S. C. J. Bennett, B.Sc., M.R.C.V.S.

the local breed when injected into European cattle. The local breeds, through centuries of exposure to cattle plague, have attained some degree of racial natural immunity, and consequently do not react so strongly to the virus of the disease as do the more finely bred and less exposed European breeds. Ordinarily, the serum from hyper-immunised local cattle is used for the protection of other cattle of local breed, and experience has shown it to be of sufficient potency. Incidentally, as some of the serum producers may be carriers of piroplasmosis, a rule is made never to inject serum unless it has been allowed to stand for at least two months. This ensures the death of any piroplasms present, and is superior to filtration in that it does not reduce the potency of the serum. The dose is calculated at 0·25 cc. per kilogram body-weight (in the case of local cattle) in order to confer an immunity of 12 days' duration.

In the experiments on Friesian cattle it was established that four times the normal dose for local cattle (1 cc. per kilogram body-weight) conferred an immunity of at least a month's duration, and that a smaller dose (0·6 cc. per kilogram body-weight) injected every 12 days would probably protect the treated animal for an indefinite period. The animals so treated were kept in the same stable as cattle suffering from rinderpest, and they did not subsequently show any symptoms of the disease, whereas two control animals, similarly housed, succumbed at the ninth and twelfth days respectively. The two foregoing tests were conducted with two months' old unfiltered serum, but a third test, similarly controlled, showed that a dose of 0·7 cc. per kilogram body-weight of fresh filtered serum would not afford an absolute immunity; a cow so treated developed rinderpest in a mild form and soon recovered.

A further test with a dose of 0·5 cc. per kilogram body-weight of two months old unfiltered serum showed that this quantity would not protect absolutely; the cow employed in the test developed mild symptoms on the eleventh day, and a further dose of 500 cc. was administered. This dose effected what was apparently a complete cure.

Incidentally, after an interval of about a week, this cow contracted, and ultimately succumbed to, East Coast fever. Autopsy revealed typical rinderpest ulcers which were undergoing regeneration in the abomasum—an incident which is of particular interest in view of the extremely mild clinical symptoms shown previously.

To test the purely curative value of the serum another Friesian cow was allowed to contract the disease naturally, and as soon as definite symptoms developed a dose of 500 cc. of unfiltered serum was given *intravenously*. As no apparent benefit was evinced a similar dose was given on the next day, and again on the following day. In spite of this treatment a very high temperature and great depression were maintained. After missing one day, two more daily doses of 500 cc. were given intravenously, with the result that the temperature was restored approximately to the normal, although the depression remained and a profuse diarrhoea set in. To compensate for the diarrhoea two doses on consecutive days of four and two litres respectively of physiological saline were injected subcutaneously. From this point onwards recovery was uneventful.

This animal also ultimately fell a victim to naturally acquired East Coast fever, and on post-mortem examination (three weeks after

the commencement of clinical symptoms) typical rinderpest ulcers were seen in the abomasum in the retrogressive stage.

The conclusions to be drawn from the foregoing experiments are :—

1. European cattle require rather more than double the dose of serum given to local cattle to protect them against rinderpest. (The dose for local cattle is 0·25 cc. per kilogram body-weight, whereas the lowest absolutely protective dose for a Friesian cow was 0·6 cc. per kilogram.
2. Fresh, filtered serum is less efficient than older, unfiltered, serum.
3. A dose of 0·5 cc. per kilogram body-weight will not protect European cattle, but will delay the appearance of symptoms. Further, an animal so treated may be cured if given a larger dose when symptoms first appear.
4. As a curative only, the serum is useful only in the form of exceedingly large and repeated doses, and even then, the treatment must be commenced at the very first appearance of clinical symptoms.
5. European cattle are very susceptible to East Coast fever. Resulting from this fact, it was to be observed that in animals which had shown only mild clinical symptoms of rinderpest the internal lesions were nevertheless very pronounced.

SCHERN (K.). **Über Rinderpest (Fünfte Mitteilung). Befunde bei Rindern nach überstandener, experimenteller Rinderpestinfektion, mit einem Anhang über Schlachtbefunde bei Rindern in Konstantinopel.** [Rinderpest (5th Communication). Conditions observed in Cattle following Recovery from Experimentally Induced Rinderpest, with a Further Note on Slaughterhouse Observations in Constantinople.] *Ztschr. f. Infektionskr. d. Haustiere.* 1920. Nov. Vol. 21. Part 2. pp. 122–137.*

This article follows previous communications by the author (see this *Bulletin*, 1918, Vol. 6, No. 3, p. 186), in which mention has been made of the recovery of cattle experimentally infected with rinderpest. The animals here studied are those which were among the cattle destined to supply virulent blood, but which, owing to their mild reaction (or total absence thereof) to experimental inoculation, and rapid recovery, were rejected as unsuitable for that purpose. Anatolian cattle only are considered, as European beasts were not available (at Pendik, Turkey).

Post-mortem examinations were made of 131 such cattle which were slaughtered at varying periods up to 155 days after experimental inoculation, particular attention being paid to the abomasum and heart as the two predilection seats of lesions. On the results of these autopsies the author classes the beasts in four groups :—

(1) Those which exhibited symptoms and which, on autopsy, showed no lesions of rinderpest (35 beasts).

(2) Those which exhibited symptoms and which, on autopsy, showed some lesions (50 beasts).

(3) Those which *exhibited no symptoms but, on autopsy, showed lesions* (34 beasts).

(4) Those which showed neither symptoms during life nor lesions when slaughtered (12 beasts).

Of these groups, the most interesting consists of animals which showed no symptoms following inoculation but nevertheless developed internal lesions—in one case, lesions were present on slaughter 155 days after inoculation.

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The persistence of these lesions naturally suggested the possibility of continued infectivity after apparently complete recovery, and in order to investigate this point it was decided to inoculate other cattle with material from the internal lesions.

In the first experiment of this series, portions of the abomasum showing lesions obtained from a recovered beast slaughtered 26 days after inoculation were minced up, mixed in a bran mash, and fed to two healthy Anatolian beasts. These two beasts were kept isolated from all others in an open paddock with an attendant who lived with them. Nobody else was allowed to approach them, so that as far as possible the most rigid measures were in force to prevent the introduction of rinderpest from without. Of these two experimental beasts one developed symptoms of high fever on the eleventh day and died on the fifteenth. Autopsy showed it to have died from a peracute form of rinderpest—severe gastro-enteritis with haemorrhages and infiltration into the wall of the intestine, together with distension of the gall bladder with green diffluent bile. The second beast showed no symptoms with the exception of a slight rise of temperature on the eighth and ninth days, and in consequence some doubts were entertained as to its susceptibility. To make sure, a dose of 10 cc. of virulent blood was given. Following upon this inoculation the animal remained quite normal for twelve days, but at this period developed a temperature of 40·5°C. (105°F.) which did not subside, accompanied by colicky phenomena. It died in three days. Autopsy showed evidence of severe sero-fibrinous peritonitis and examination of blood-smears showed evidence of anaplasmosis. The author therefore concludes that this beast did not die of rinderpest and was consequently immune.

Material for the next experiment was minced abomasum tissue of a beast which had been slaughtered as immune to rinderpest, and which at post-mortem examination showed *no lesions*. A beast fed with this material did not show any definite rinderpest symptoms, but neither did it when tested as to its susceptibility by inoculation with 20 cc. of virulent blood. It was slaughtered, but no lesions of rinderpest were found. This experiment must, therefore, be discarded, as the experimental animal was presumably naturally immune, so that no conclusion can be drawn as to the virulence of the experimental material originally given.

Attempts to produce rinderpest by feeding with material from the abomasum lesions of a recovered beast slaughtered 70 days after inoculation, from which it had recovered, also failed; but here again the two animals tested subsequently resisted natural infection by co-habitation with animals at the height of the disease.

Further attempts at infection with similar material from two cattle recovered from mild clinical rinderpest slaughtered 105 and 108 days, respectively, after inoculation with virus also failed.

Results of experiments up to this point tend to show that cattle which have to all outward appearances completely recovered from rinderpest, may, nevertheless, be possible carriers of infection, since material from such a beast slaughtered 26 days after inoculation with virus produced fatal rinderpest in one test animal fed with it, and a very mild attack in another. Material from recovered beasts slaughtered at 70, 105 and 108 days after inoculation failed to reproduce the disease, but material from a 101 days' case produced doubtful, mild symptoms. The argument is thus that although all recovered

animals are not infective, nevertheless, as seen by experiment, some of them may harbour the virus. It also appears that as material used 26 days after inoculation produced fatal rinderpest and that used after 70, 105 and 108 days did not, the danger decreases as time after recovery progresses.

As a sequel to the foregoing researches, investigations were instituted in order to establish whether beasts slaughtered for food, and, therefore, apparently healthy, still showed lesions. Examination of about 60 carcases in the slaughterhouses of Constantinople showed that about 75 per cent. still harboured rinderpest lesions in the abomasum or heart.

A summary of these researches, therefore, shows that of 131 cattle inoculated with rinderpest virus in which severe symptoms did not develop, 35 beasts (28 per cent.) showed mild symptoms and recovered; moreover, on post-mortem examination, no persisting lesions were seen. Of 50 beasts (38·1 per cent.) showing similar symptoms, persisting lesions *were* seen on post-mortem examination, even up to 140 days after inoculation.

Again, the fact that an inoculated animal shows no symptoms does not necessarily imply that it has not developed the disease, since in 34 beasts (25·9 per cent. of such cases) post-mortem examination revealed rinderpest lesions. Such a conclusion is, however, warranted in some cases, since some beasts showed neither symptoms nor post-mortem lesions.

Furthermore, feeding experiments with material from persisting lesions demonstrated that it is possible for the virulence to persist also, even up to 101 days. The degree of virulence appears to decrease with time.

The discovery of persisting rinderpest lesions in apparently sound cattle in slaughterhouses is of great importance, as such beasts may have been harbouring infection and have probably been driven long distances over the main roads. They may thus have been disseminating the virus of the disease. Thus, from the national economic standpoint, a country can only protect itself against the introduction of rinderpest by the absolute exclusion of animals coming from a country in which the disease is indigenous—even a lengthy period of quarantine may not suffice, since the disease may exist although it is impossible to establish the fact.

i. RUPPERT (F.). **Gibt es bei Rinderpest Virusträger** [Do "Carriers" of Rinderpest exist?]

ii. SCHERN (K.). **Ja! Es gibt Virusträger bei Rinderpest.** [Yes! Rinderpest "Carriers" do exist.]—*Berliner tier. Woch.* 1921. Feb. 24. Vol. 37. No. 8. pp. 85–88.*

iii. RUPPERT'S **Concluding Remarks.**—*Ibid.* Mar. 17. No. 11. p. 126.

The discussion of the above question, following as it does the foregoing articles, is of particular interest and is quoted at some length.

i. RUPPERT'S CRITICISMS. SCHERN'S conception that there are carriers of rinderpest arises from a single positive transmission experiment. A bullock was slaughtered 101 days after infection and ulcers from its abomasum fed to a second beast, which developed clinical rinderpest.

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The other positive case wherein similar ulcers from a beast slaughtered 26 days after inoculation proved infective, cannot be admitted as evidence, since it has been established that the blood of a chronically affected animal may be virulent up to 30 days. (HUTYRA and MAREK, *Die orientalische Rinderpest.* 1916.) Thus, based on a single experiment, conducted without any control, SCHERN attempts to strike at the root of our preconceived ideas of immunity. I do not need to offer any suggestion as to the explanation of this single positive result carried out at a rinderpest station. The other arguments resulting from field tests are only hypotheses and, so far, not established.

Rinderpest immunity differs from any protozoan immunity, and no comparison of the two can be entertained; moreover, there are fundamental differences between rinderpest and other contagious diseases in which carriers are recognised (*cf.* typhoid fever).

Admittedly it is not always possible to establish the origin of rinderpest outbreaks, and their instigation by carriers would be sufficient explanation. However, theories are no good. The last outbreak in Belgium, first thought to have originated from carriers, has since been proved to be due to another cause—some zebus quarantined in Antwerp were not healthy, in fact seven of them died. There is no information as to whether any of them had died in transport, but it is likely that they were injected with rinderpest serum in Bombay. No other information is to hand.

According to a Russian commission (*cf.* HUTYRA and MAREK, *loc. cit.*), the virus of rinderpest may remain alive in the marrow of dried bones for 30 days, and for a similar period in incompletely dried hides which had been salted for two or three days. BOYNTON (*Philippine Jl. of Science*, 1913, Vol. 8) proved the persistent virulence of blood in a leech for 25 days, and WÖLFEL was able to infect animals with material from bones which had been buried for a month and dug up again. From these facts, it is to be realised, that very little is really known of the rinderpest virus, and, consequently, a clear scientific explanation as to the cause of any particular outbreak cannot be put forward.

Against the single positive experiment of SCHERN, one must consider the results obtained by MROWKA (*Ztschr. f. Infekt.-Krankr. d. Haust.*, Vol. 15, p. 139), by WARD, WOOD and BOYNTON (*Philip. Jl. of Science, B., Trop. Med.*, Vol. 9, p. 49), and by WÖLFEL and myself. MROWKA, in China, fed susceptible animals with old abomasum ulcers from rinderpest carcases, but failed to reproduce the disease. WARD, WOOD and BOYNTON, in the Philippines, investigated the possibility of recovered animals being able to infect others by direct contact; all attempts failed. WÖLFEL and myself inoculated susceptible animals with as much as three litres of blood from recovered beasts, but failed to reproduce the disease in any case.

I do not wish to contradict SCHERN's theory on the grounds of these researches alone, but should like to point out that it is not definitely established that the ulcers of the abomasum, as described by SCHERN and MROWKA, were unequivocally referable to antecedent rinderpest. In East Africa exactly similar lesions have been observed by us in cases of East Coast fever. LICHTENHELD, as early as 1905, described them in regions to which rinderpest was entirely foreign, and they were considered to be in the nature of emboli consisting of masses of KOCH's blue bodies. At Mpapua it was definitely proved that animals were in possession of such lesions, but were not affected with rinderpest, and therefore the lesions were in no way referable to rinderpest.

A further interesting point is as follows:—In East Africa, before the war, rinderpest was enzootic as far as the Central Railway (*Mittellandbahn*), but south of this line the country was free from the disease. Realising that animals from the hitherto free district would be good subjects for the provision of virus, we brought a number of them to our institute for that purpose. We found on inoculation of various lots that from 2 per cent. to 5 per cent. were immune. They must have become immune as a result

of previous infection, so that one may assume that as they came from a district carrying 200,000 head of cattle, there would be, say, 4,000 such immune animals—presumably recovered animals. It seems reasonable to suppose that among this 4,000 there would be a few carriers. Such appears not to have been the case, as no outbreak was ever observed prior to invasion of the territory by the allied armies in 1917.

SCHERN'S opinion that carriers exist, would suggest that immunisation by the simultaneous method is hazardous; carriers would of necessity be created, and these would infect young beasts, so that rinderpest could never be stamped out. The weight of evidence is in direct opposition to this, particularly in countries where a strict veterinary inspection cannot be enforced. MARTOGLIO (*Ann. d'Igien. sperim.*, 1911, Vol. 21, No. 2), in Eritrea, attempted, side by side with each other, the serum-alone and the simultaneous methods; he considers the simultaneous method the better. Again, in Russia, VON OSTERTAG (*Ztschr. f. Infekt.-Krankr., etc., d. Haust.*, 1917, Vol. 18, p.1) states that attempts to put down rinderpest by the serum-alone method failed, owing to the fact that a protection of sufficient duration could not be produced; the simultaneous method, however, afforded good results. Moreover, in districts cleared of the disease, no further outbreaks occurred. In fact all information as to the sequelae of simultaneous anti-rinderpest inoculation in Eritrea, Russia, the Caucasus, Egypt, India, Turkey, Abyssinia, East Africa and the Philippines contra-indicates the possible existence of carriers. If the existence of such is to be established, the fact must be proved with a larger amount of material and on much broader lines.

ii. SCHERN'S ANSWER. I cannot agree with RUPPERT, and I do not think that my communication was made without sufficient confirmation. I have performed experiments, and when RUPPERT can present any facts which refute my results I will concur with his "opinion" (*Ansicht*). RUPPERT knows that a single positive result is determinative in spite of any number of negative ones. Carriers of rinderpest are not easy to come by, and fortune has not smiled on RUPPERT and the others; however, that detracts nothing from the correctness of my experiments. Moreover, I do not stand alone in my conclusions, as shown by GÄRTNER'S work (*Berliner. tier. Woch.*, 1920, No. 43), in which he heads a section of his work "Goats as virus carriers in rinderpest." STAZZI has also demonstrated the existence of carriers.

The suggestion that the experiments were not sufficiently controlled is incorrect, and for that matter anybody, even in Germany, can convince himself that feeding with normal abomasum tissue will produce no phenomena which might be confounded with rinderpest.

As to the experiments having been conducted at a rinderpest institute, such work is usually done at these places—for instance, foot-and-mouth disease experiments are performed at the foot-and-mouth disease institute at Rheims. Who, therefore, can agree with RUPPERT'S words when he says: "I need offer no explanation as to the value of researches conducted in such an institution"? The experiments were carried out "near" (*bei*) a rinderpest station, but in the open, and I hold that it is in connection with such an institute that experiments of this nature should be conducted; the whole matter turns on who does the experiments and how they are done. With all modesty, I may remark that I am no beginner at this kind of work, but have fifteen years of practical experience behind me.

It is not clear why any reference should be made to the difference between immunity to rinderpest and to protozoan diseases, and as to the persistence of infective virus in bones or hides: the question here is of carriers—living animals; moreover, there is a great difference between an animal with a chronic form of rinderpest and one, to all clinical appearances, completely healthy.

MROWKA is of the same opinion as myself, although similar feeding experiments in his hands, and in the hands of several other authors,

produced no results. As shown in my original communication, many of my feeding experiments were also negative.

Referring to the work of WARD and his collaborators, the difference between virus "carriers" (*Virusträger*) and virus "spreaders" (*Virus-ausscheider*) is ignored. The experiment of putting recovered animals in contact with non-susceptible ones, cannot prove whether the former are carrying the virus, but only whether they are excreting it, and, moreover, in sufficient mass to cause infection of the latter.

As to the possibility of confounding a rinderpest ulcer in the abomasum with a lesion of East Coast fever, this is a question that is being investigated by histologists, and the information to hand is not very definite. A practical acquaintanceship with the two diseases induces one to discard any tendency to admit their identity.

In consideration of the estimated 4,000 immune animals south of the Central Railway which are in contact with 200,000 susceptible animals, apart from noting that the question is here rather of "spreaders" (*Ausscheider*) than of "carriers" (*Träger*), I should like to ask how many of our European cattle would withstand infection in the same circumstances ?

The question of carriers appears to be of great importance, especially from the standpoint of simultaneous inoculation, but it is impossible to make any categorical statement as to the advisability of the latter. The question is extremely complicated from economic, medical and political points of view. However, confining one's considerations to countries in which rinderpest is enzootic, one cannot agree with RUPPERT'S statements. Among the countries quoted Turkey is mentioned, and I know from my own experience in Asia Minor, that the Turks discarded the simultaneous method of immunisation years ago, because so many secondary outbreaks followed this procedure. The serum-alone method only is employed.

The conclusion is that the answer to RUPPERT'S query must be : "Yes, carriers of rinderpest do exist."

iii. An explanation is here given as to what would be adequate controlling of the rinderpest transmission experiments cited by SCHERN (see 5th communication and discussion above). RUPPERT says :—

"If I were performing a similar experiment to that of SCHERN on a beast in the vicinity of a rinderpest institute, I should consider it necessary to have two or three healthy animals alongside the experimental one, in order to be able to exclude the possibility of infection from without through the medium of food, water, insects, men or other animals. With the first rise of temperature (in the experimental beast) the control animals should be isolated and continue in a state of health."

MISCELLANEOUS.

DONATIEN (A.) & ESPÉRANDIEU (G.). **Le "Boukhchem," maladie enzootique des chiens kabyles.**—*Bull. Soc. Path. Exot.* 1920. Dec. 8. Vol. 13. No. 10. pp. 811–816.

Mention has already been made of this canine contagious disease by HECKENROTH in Senegal, 1916 (this *Bulletin*, 1918, Vol. 6, No. 4, p. 250), by VELU and by MARTEAU in Morocco in 1918 and 1919 (this *Bulletin*, 1919, Vol. 7, No. 4, pp. 286 and 287), and a violent outbreak was observed by the authors in the Department of Constantine in Algeria in December, 1919, to April, 1920. It had already been

described in this district by Donatien in 1911 and 1912. A considerable mortality took place among the kabyle dogs, and very few escaped infection in affected villages.

The first sign of disease in the dog is a coryza manifested by a more or less abundant serous discharge, and by a pruritus which causes the animal to rub its face as if in an attempt to expel parasites from its nasal cavities. The chief signs of the disease soon supervene, which may be divided into nervous and respiratory symptoms. One may also note digestive, urinary and circulatory derangements as accessory signs. The nervous symptoms are by far the most marked and are seen in almost all cases. They exhibit considerable variation in nature and intensity in different subjects, for in some they may take the form of locomotor troubles, while in others they may be seen as sensory troubles. The locomotor troubles take the form of marked changes in the attitude and progression. The affected animals carry their heads low, walk with unsteady gait, and there is often incoordination between the movements of the fore and hind quarters. The subjects frequently fall, and weakness of the hind quarters becomes more marked until it develops into paresis or even paraplegia. Clonic contractions of certain muscular masses are very often seen, especially in the region of the loins and croup, while sometimes tetanic contractions of the neck may be seen.

Hyper-aesthesia is almost constantly noticeable at the back of the neck, and it may be seen on the croup. The sensory organs remain most commonly unaffected, but sometimes disturbances of the visual apparatus may be seen, while in some cases the dogs become quite deaf.

Animals preserve their intelligence and only very rarely exhibit madness, their attitude being more usually that of profound depression. The sympathetic system is affected, so that one may observe clonic contractions of the diaphragm and pharyngeal spasms, leading to total or incomplete inability to swallow.

Respiratory symptoms are less commonly observed, but most often they appear simultaneously with the nervous disorders, but in a few rare cases they may appear alone. The serous discharge becomes mucous and then muco-purulent, and increases in amount, it then dries up in the form of brownish crusts around the nose, hence the native designation "Boukhchem" (disease of the nose). Dogs sneeze, but cough very little, whilst they are affected with intense dyspnoea after the least effort. Dyspnoea may, moreover, be seen without any other respiratory trouble. The appetite and thirst are usually maintained. Besides nervous vomitions, the animals may have diarrhoea, and in cases of paraplegia there is retention of the faeces and urine. As a rule the urine is opaque and dirty looking, sometimes reddish. The pulse is small and thready, the general condition is severely affected, although the appetite is maintained, and emaciation becomes more and more marked until the dogs die in a condition of extreme weakness. Death takes place after a variable interval of time (3 to 20 days), but in rare cases it may take place after even 2 to 5 or even more months. The more chronic cases are those in which the nervous symptoms only are seen. The high mortality leads to the extinction of dogs over fairly considerable regions.

Examination for the presence of lesions was made particularly in connection with the nervous and respiratory systems. The cerebral and spinal meninges were congested. The cerebro-spinal fluid was

abundant and turbid, the nerve centres showed a little congestion. In two cases, acute unilateral pleurisy with broncho-pneumonia of the opposite side was seen. No parasites were found in the sinuses. Signs of intoxication were noted in connection with the other organs. In nearly all cases swellings due to *Spiroptera sanguinolenta* were noticed along the course of the intra-thoracic portion of the oesophagus.

Etiology.—The disease was identifiable with certainty only in the dog and almost entirely in the kabyle dog. During the progress of an outbreak the European breeds of dogs may likewise become affected, but the disease develops in them in a mild form. Hybrid dogs appear to possess an intermediate susceptibility, and in them especially may be noted all cases of incomplete recovery with persistence of nervous troubles. In the native breed age plays no part. The disease appears particularly during the colder months. It appears in a centre and then spreads from one native group to another with a certain rapidity. In the last observation it spread a distance of 50 km. in two months. Clinical observation throws no precise light on the nature of the mode of transmission. In view of the fact that madness is but rarely seen, it is but little probable that the virus is transmitted by biting. In the villages the animals live in very close proximity, and it would thus appear highly probable that the serous discharge seen at the beginning of the disease contains the virus.

Experimental investigation, however, gave but little better results than clinical observation, and attempts at transmission by cohabitation, smearing of nasal discharge, and injection of blood gave negative results. A dog, however, inoculated with brain material intra-cerebrally became somnolent in four days and remained in this condition up to the time of its death, 22 days after the inoculation, although the animal's appetite was maintained it developed a condition of extreme emaciation. Post-mortem examination showed no noteworthy lesion. The brain of this animal was inoculated into another healthy dog, with negative result. This experiment could not, therefore, be regarded as positive. Finally, rabbits were inoculated intra-muscularly with large quantities of brain material, with quite negative results. The disease, therefore, could be differentiated with certainty from rabies, and clinically there was but little similarity between the two affections. The symptoms, existence of incomplete recoveries with persistence of nervous derangement, the lesions, and failure to transmit the affection at a slightly advanced stage, are reminiscent nevertheless of distemper, but the disease could be differentiated inasmuch as dogs of all ages are attacked, nervous symptoms were almost constant, and the typical pustules were not observed on the skin.

REPORTS.

INDIA. **Review of Agricultural Operations in India, 1919-20. Live Stock. Chapter VIII.**—pp. 82–99. 1921. Calcutta : Supt. Govt. Ptg. [Price, Rs. 1-4.]

1. *Prevention and Treatment of Disease.*

Details of the work done by the Civil Veterinary Departments during the year under review are given in tabular form. The large increase in the number of cases treated in hospitals and dispensaries,

and by officers on tour, clearly indicates that steady progress has been made in winning the confidence of the agricultural population in the medical treatment of their live stock, an indispensable condition for the success of the work of the department. As a further testimony to this increasing confidence on the part of the general public, it is mentioned that in some provinces, for instance, in Bombay, Madras and the Punjab, private individuals have come forward with offers to establish veterinary hospitals at their own expense.

During the year, rinderpest prevailed in a virulent form in many parts of the country, and was mainly responsible for the rise in the mortality under contagious diseases, the reported numbers of which rose from 2,63,372 in the preceding year to 3,37,396 in the year under review. The number of inoculations made was 7,09,795, but a far greater advance in this direction might have been recorded had it been possible to maintain a regular supply of serum from the Imperial Bacteriological Laboratory at Muktesar.

Although the veterinary staff has been strengthened in some provinces, the resources of the department continue to be inadequate for the proper performance of the heavy and responsible task set before it. In a country in which the bovine population alone exceeds 145,600,000 head, it is idle to expect real progress in combating disease with a comparatively small band of workers, however zealous they may be. The annual loss that the Indian cultivator suffers from preventible diseases of cattle amounts in the aggregate to enormous figures. These losses include not only the market value of the cattle which succumb to disease, but include the set-back to production, growth and vitality, as well as the loss and inconvenience incurred in field operations. In India, as in other countries, where the mainstay of the farmer is his live stock, the necessity for a properly organized veterinary department is one of the very first considerations, and an appeal to figures to prove that the amount of preventible mortality far exceeds the cost of prevention seems scarcely necessary. It cannot be hoped, however, that the present annual expenditure of 352 lakhs on the department in India and Burma, amounting to less than one-half anna per head of bovine population, will go far to provide an adequate organisation.

2. *Incidence of Disease.*

Bombay. The year appears to have been a comparatively healthy one for stock, the recorded number of deaths from contagious diseases being 8,647 against 10,550 in the preceding year. The decrease in the mortality from rinderpest was particularly marked. Lymphangitis in cattle was recorded for the first time in the Presidency, and was found to be prevalent to some extent in the Kanara District. The disease was investigated at the Imperial Bacteriological Laboratory at Muktesar. [See preceding number of this *Bulletin*, p. 22.] Meanwhile, cases are being treated by surgical methods.

Among equines there were 154 reported deaths from surra against 149 in the preceding year. The disease was almost entirely confined to *tonga* lines. Every endeavour was made to instruct the owners of horses as to the nature of the disease, the manner in which it spreads, and the methods of prevention. As a result of the precautionary measures taken, the Chimbur Pinjrapole remained free from the disease for the first time for a number of years.

Madras. The total number of deaths amongst cattle from contagious diseases dropped to 59,297 in 1919–20 from 76,114 of the previous year. There was a decrease under all diseases except anthrax, in which, however, the increase was negligible. Seven cases of surra were confirmed microscopically, but several deaths occurred from the disease amongst the buffaloes belonging to the Forest Department in South Coimbatore Division.

Heavy mortality amongst the sheep and lambs of the agricultural farms at Hagari and Bantanahal in Bellary District occurred during the year and many of the cases showed pneumonic lesions. From the Cattle Quarantine Depôt at Tuticorin, 9,918 cattle were passed for shipment to Ceylon against 4,919 in the preceding year, while at the request of the Colombo authorities, 7,807 animals were inoculated against rinderpest before they were shipped.

Bengal. Contagious diseases were responsible for 14,569 deaths compared with 15,569 in the preceding year. There was a very marked decrease in the death roll under anthrax, the number recorded being 88 only against 2,555 in the previous year. The mortality resulting from rinderpest and haemorrhagic septicaemia was, however, greater than in the preceding year, in spite of the fact that a large number of animals were protected from the ravages of diseases by timely inoculation. A prominent feature of the year was the appointment of veterinary union committees and sub-committees to deal with veterinary matters. Many of the difficulties at present experienced by the Veterinary Department could be easily overcome by a display of energy on the part of such organizations.

Bihar and Orissa. Outbreaks of contagious cattle diseases were on the whole less virulent and more localized in character, the reported number of deaths being 15,781 compared with 25,658 in the previous year. The scheme for inoculation of cattle in Chota Nagpur through the agency of a special staff of locally trained inoculators proved a failure and was abandoned towards the close of the year.

United Provinces. The mortality from contagious diseases rose from 16,233 in the preceding year to 42,715 in the year under review. In spite of vigorous campaigns organized against the disease, rinderpest assumed a virulent form, and levied a toll of no less than 32,572 animals. Surra appeared only in the district of Naini Tal, and 40 animals either succumbed to it or were destroyed under the Glanders and Farcy Act. Seven new hospitals were added during the year, raising the total number to 95.

Punjab. Contagious cattle diseases accounted for 56,089 deaths compared with 28,715 in the preceding year. The increase in mortality was chiefly due to very severe outbreaks of rinderpest, aggravated by the debilitating influence brought on by the last fodder famine and consequent susceptibility of stock to disease. Surra was less widespread than in the previous year, while no cases of dourine were recorded, probably due to the thorough measures adopted by the department against the spread of this disease. The foot bath erected for the stock at Hissar was again successful in diminishing the feet deformities which usually follow untreated cases of foot-and-mouth disease.

Central Provinces. The number of deaths from contagious diseases was 33,052 as against 21,344. Rinderpest was widespread throughout the province and took a virulent form in many districts. Only 81 fatalities from surra were recorded as against 264 in the preceding year.

A new dispensary was started at Warora, bringing the provincial total to 81. More applications were received for the establishment of new dispensaries and are under consideration.

Assam. There was a considerable increase in the number of deaths reported from contagious diseases, the figures rising from 20,819 in 1918–1919 to 39,188 in the year under review. Rinderpest caused 16,242 deaths compared with 7,239 in the preceding year, while deaths from foot-and-mouth disease and haemorrhagic septicaemia were 79 and 93 per cent. more than in the previous year. There was an extensive outbreak of surra in Maulvi-bazar Sub-division of Sylhet District. The disease was also detected in four other districts where, fortunately, it was not so widespread. The unhealthiness of the season emphasized the difficulty of coping with extensive outbreaks of contagious diseases with the existing staff. The question of increasing the number of reserve officers for such contingencies is under consideration.

Burma. Rinderpest caused a heavy death roll, the mortality being more than double the number recorded in the preceding year. The responsibility for the widespread mortality is ascribed to the apathy and neglect of the cattle owners. Foot-and-mouth disease prevailed with varying degrees of intensity throughout the year. Several cases of surra were recorded, including one calf and one dog. The disease was prevalent in the Shan States.

North-West Frontier Province. During the year 30,000 cases of contagious diseases were reported, of which 3,087 proved fatal, as against 31,293 cases and 7,224 deaths in the preceding year. The deaths were mostly due to rinderpest. One hundred and six cases of surra occurred during the year, resulting in 75 deaths.

Sind. The year was a healthy one for stock. Mortality from contagious diseases was low, the total number being 1,688 against 4,125 in the previous year. There was a slight increase in mortality due to surra and glanders.

Baluchistan. The number of reported deaths from contagious diseases was 3,277 as against 6,442 in the preceding year, but the Superintendent, Civil Veterinary Department, in charge of the province, reports that no reliance can be placed on the statistics, and it is certain that many outbreaks of contagious diseases were not reported. Improvement in the control of contagious diseases cannot be reasonably expected until a separate Superintendent for the province is appointed.

Rajputana. The total mortality from contagious diseases was reported to be 252 against 128 in the preceding year. No outbreaks of epizootic diseases were reported from Merwara during the year, but it is very improbable that none occurred.

3. *Preventive Inoculation.*

With regard to some of the contagious diseases, *e.g.*, rinderpest, haemorrhagic septicaemia, and anthrax, it is stated that little can be done in the way of treatment, and from 75 to 99 per cent. of the affected animals are generally lost. A table is given showing the very successful results of preventive inoculation in rinderpest, haemorrhagic septicaemia, anthrax, and blackquarter. In rinderpest, for example, where the normal mortality is 75 per cent., the actual deaths amongst over 680,000 animals inoculated with anti-rinderpest serum amounted to only 0·35 per cent. Complete prevention of rinderpest appears to depend on two things: (1) the provision of a large staff of inoculators;

(2) the co-operation of the people themselves. In one district a bad outbreak of rinderpest was very successfully and speedily controlled through the prompt action of the people themselves in reporting the disease and carrying out the instructions of the Veterinary Department. Vaccination against haemorrhagic septicaemia is steadily increasing in popularity owing to the fact that it reduces the mortality to less than 0·05 per cent., although the mortality among affected animals is as high as 75 to 90 per cent. Requests are now regularly received from certain low-lying tracts liable to the disease to have the cattle vaccinated before the commencement of the rainy season.

Prophylactic measures against anthrax have also been highly successful. Results of injections made, indicate that the mortality among inoculated animals does not exceed 0·22 per cent.

In Madras, where the District Magistrates exercised the powers vested in them, and closed those fairs to which contagious diseases were known to have been imported, it was found that in many instances the people again held unauthorised gatherings of cattle, the result being that diseases could not be got under control as quickly as was expected.

More efficient measures to prevent the spread of disease are undoubtedly required, and legislative measures, in some form or other, restricting movements of diseased cattle from one locality to another, and the compulsory segregation of infected animals, are much needed.

Surra has now been notified as a disease to which the Glanders and Farcy Act applies.

4. *Breeding.*

Cattle Breeding. The heavy decrease in the cattle population in parts of India has naturally caused a good deal of anxiety in certain quarters. Epizootics of disease and fodder famines are no doubt the two main causes of the decrease. It is stated that cattle rearing, in spite of the high prices of draught animals, is still less profitable than crop-growing.

The efforts of the Veterinary Department to improve the working cattle are now being supplemented by the work of the Agricultural Department in breeding higher milk-yielding cows.

Sheep Breeding. Although there are several difficulties in the way of improving the Indian sheep, they are by no means insurmountable; thus, while experiments in progress at Bantanahal in Madras, like those in some of the other Provinces, have met with but little success, the attempts made in the United Provinces, the Punjab and the North-West Frontier Province, continue to give increasingly promising results.

A summary is given in which are outlined the programmes of the various Provinces.

5. *Veterinary Education.*

For the training of students in veterinary science, there are colleges provided at Bombay, Madras, Calcutta and Lahore, and schools at Insein and Taunggyi in Burma. The colleges at Bombay, Madras and Calcutta continued to give a three-year diploma course in English, while the one at Lahore held a similar diploma course in the vernacular.

It is proposed to give a revised course at the Lahore college, involving four years instruction in English, and this will be brought into force as soon as the necessary arrangements have been made. Meanwhile the four years' vernacular course, as at present conducted, has been definitely abandoned. The total number of students who passed the final examinations of the colleges during the year was 153, as against 142 in the preceding year.

The scheme for establishing a veterinary college for the United Provinces, which has been delayed owing to the war and other reasons, is now receiving the attention of Government. It is hoped that building operations will shortly be started at Lucknow, where a site has already been selected.

For post-graduate training, a revised course of instruction has been drawn up for the Lahore veterinary college, and will be instituted in due course, while proposals for the institution of similar training at the Madras veterinary college and in the veterinary research laboratory at Nagpur, are under consideration.

The veterinary schools at Insein and Taunggyi give vernacular courses of three years and a year and a half respectively. Although these schools are attracting candidates in larger numbers, they do not fully meet the requirements of Burma, and provision will shortly have to be made for higher veterinary education, with a view to the training of Deputy Superintendents in the Province.

For educating the public in veterinary matters, leaflets dealing with prevention and treatment of cattle diseases were freely distributed, and lectures on animal diseases, cattle breeding, etc., given to cultivators and stock owners congregated at fairs and shows.

6. *Veterinary Research.*

As mentioned in the previous reviews, depletion of staff and increased routine and administrative duties have greatly curtailed opportunities for research work, the greater part of which was carried out at the Imperial Bacteriological Laboratory, Muktesar, and related to the following subjects :—

Rinderpest and Haemorrhagic Septicaemia. The experiments in progress during the year 1918–1919 regarding infectivity of hides of animals that had died of these diseases were continued during the year under report.

Johne's disease. A herd infected with this disease in Bihar was tested with avian tuberculin. As it was impossible to obtain permission to kill any of the reacting animals, the value of the test could not be determined.

Tuberculosis. The inoculation experiments foreshadowed in last year's report have been completed. [See this *Bulletin*, 1920, Vol 8, No. 3, p. 227.]

Bovine lymphangitis. With material received from the Madras Presidency experimental work was carried out, and the causal organism was isolated. [See this *Bulletin*, preceding number, p. 22.]

Surra. On the recommendation of the Surra Committee, an experiment was initiated at the Muktesar laboratory to ascertain the effects on different animals of the inoculation of strains of the *Trypanosoma evansi* derived from other species. Experiments in curative drug treatment were also carried out. Detailed reports by the Camel Specialist (Cross, H. E.) on the course that surra runs in camels,

when naturally contracted and when artificially inoculated, and on the course that camel surra runs in ponies, buffaloes, and other animals, are under publication [see page 58]. Further experiments in the drug treatment of surra are being carried out by the Camel Specialist. The Imperial Pathological Entomologist continued his work on surra and carried out a fly survey in the Punjab and the North-West Frontier Province.

In the United Provinces, the research and experimental station at Badshahbag continued to fulfil a useful purpose in affording opportunity to the staff for observation and study of disease and methods of research. Some inquiries have been carried out in regard to cattle tuberculosis, spirochaetosis in fowls, and *kamri*. Investigations regarding the most economical and effective form of drug treatment for the numerous internal and external parasites of sheep and cattle, as well as the prophylactic and curative effects of various vaccines, have also been carried on.

UGANDA PROTECTORATE. **Annual Report, Department of Agriculture, for the Year ended 31st March, 1920.—Report of the Acting Chief Veterinary Officer** [RICHARDSON (U. F.)]. pp. 35–40. F'cap. 1921. Entebbe: Govt. Ptr.

Rinderpest. As usual, the chief feature in the Uganda Report is the account given of rinderpest. This disease had swept through the Buganda Province during the preceding year, and appeared in the Toro and Ankole districts of the Western Province in the early months of 1919. Owing to the rapid spread of the disease, shortage of staff, and difficulty of getting serum quickly to the districts, effective work could not be commenced until the end of March, 1919, and when the year began rinderpest existed just west of Mbarara in Ankole, was widespread in the Masaka district of Buganda, and was fairly prevalent in the south-eastern corner of the Toro district.

In the Buganda Province a few scattered outbreaks occurred in Kiagwe County of the Mengo district, but these outbreaks were stamped out and no serious loss occurred. In the Masaka district only small groups of cattle had escaped the disease, which had been devastating this district since December, 1918. These groups were immunised with serum as far as possible. During the outbreak 40,000 out of 52,000 cattle are reported to have been lost in this district.

Western Province. Rinderpest had appeared in Eastern Ankole in January, 1919, and by the end of March, 1919, it had swept through the eastern half of the district and appeared to the west of Mbarara. The disease, however, was quickly got under control, thanks to the efforts of the officers, and an attempt was made to create an immune belt of cattle, immediately to the west of Mbarara, by drawing the cattle from this area eastwards, immunising them, and then returning them to their grazing grounds. By the beginning of November this belt appeared to have been completed and rinderpest had not broken out to the west of it. Towards the end of December, however, it was found that the disease existed in the County of Kazara, west of this belt, where cattle were extremely numerous, and owing to the difficulties with the native population, the disease spread and appeared in the neighbouring Belgian territory, and in March, 1920, in the Ruzumburu County of the Kigezi district.

In September, 1919, game were reported to be dying on the southern shore of Lake Edward in the Kigezi district; the country along the shore of this lake is uninhabited, and infested with buffalo and other game. Hunting parties were introduced in order to prevent the infected game breaking west or south. The object was partly attained in that the game were kept out of inhabited areas which are very rich in stock. However, the game did break westwards, and infection was thereby spread to the Ishasha Valley and the Congo Territory. The disease broke out in cattle in the Kigezi district in March, 1920, having probably been introduced from Ankole. It was hoped that a large proportion of the cattle in this district would be saved.

In the Toro district the disease broke out in January, 1919, but measures taken prevented the spread of the disease, except through the southern part of the district, then infested with enormous numbers of buffalo. The main quarantine line was established along the Kampala—Fort Portal main road, and the disease never spread to the cattle areas north of that line. As many as possible of the cattle south of the line were immunised, but owing to shortage of staff only a small proportion of this work could be accomplished.

Eastern Province. Small outbreaks continued throughout the year in all the districts of this Province, but little work could be done in combating the disease.

Rinderpest Inoculation.—During the year the number of cattle inoculated with serum and virulent blood was as follows:—Buganda Province, 1,638 adults (with 12·5 per cent. mortality) and 220 calves; in the Toro district, 3,727 adults (with 20 per cent. mortality) and 780 calves; Ankole district, 30,393 adults (with 11·9 per cent. mortality); Eastern Province, 1,662 adults (mortality unknown) and 98 calves. The losses in calves were about 60 per cent.

In adults, the high average mortality in Toro was chiefly due to complications with trypanosomiasis. In Ankole, losses varied greatly in different inoculation centres, and they would have been much less but for complications with trypanosomiasis and redwater. 275 cattle were re-inoculated to test their immunity, but did not react to the second inoculation.

Pleuro-pneumonia. This disease appeared in all probability first in Kitgum in January, 1919, and a definite report of its existence in Karamoja was received in November,1919, where it is estimated to have caused the loss of from 50–60 per cent. of cattle in the district. In December the disease was found to exist in Teso and Busoga districts, and was suspected in Bukedi. Temporary measures appeared to have been successful in preventing further spread, pending the arrival of a proper staff for dealing with it.

Trypanosomiasis. This disease was encountered in almost every district in which work was being carried on. In Ankole losses were reported to be heavy, apparently due mainly to the movement of cattle into tsetse areas with a view to avoiding rinderpest, and bringing the remnants of herds into contact with other remnants which had suffered from rinderpest. In Toro many cases were encountered in inoculation camps, but isolation measures averted a serious epizootic. In Buganda two transport herds working from Mityana to Kampala were completely exterminated. These animals had been working for over four years with only very small losses, and they have now been replaced with fresh cattle which have been working satisfactorily and over the same roads for months.

In Busoga and Tango, extension of old tsetse areas is believed to have occurred leading to the infection of cattle along their borders. In Kampala no cases have occurred since dipping has been commenced regularly in July. This is said to be remarkable in view of the regular incidence of the disease which usually occurs. Of the cases under treatment in Kampala during the year, 23 were dismissed as cured, 8 died, and 7 were slaughtered as they failed to respond to treatment. No cases of relapse after cure were encountered. The mortality in untreated animals was apparently 100 per cent.

Foot-and-mouth disease. One outbreak was encountered in Ankole in cattle brought in for inoculation against rinderpest.

Tuberculosis. No further cases came under observation during the year.

Anthrax. One outbreak in Ankole.

Biting flies. Stomoxys were extremely numerous in the months of January, and June in Mengo district, and large numbers of cattle are believed to have died owing to worry caused by these flies. Owners who adopted the plan of keeping cattle in huts during the day, and grazing them at night, reported a cessation of deaths and marked improvement in the condition of their cattle. Measures taken for preventing mortality among transport cattle are explained, and the work during the year, it is stated, tends to show that with proper supervision and with veterinary assistance available, the danger from trypanosomiasis, which has been the chief cause of loss to working cattle, can be successfully combated.

The Kampala dip was re-started in June, 1919, and used regularly throughout the rest of the year. There was an immediate cessation of trypanosomiasis in dipped herds, although cases continued to occur in two undipped herds and the dipping effected a marked improvement of cattle in the township. Losses among calves also ceased. Dipping was performed on Wednesday and Saturday of each week, using the laboratory dip of three days' strength. Calves were not dipped until they were two months old. The owners state that calves contract East Coast fever in a mild form, but further work requires to be done in order to ascertain the degree of immunity acquired by the young stock.

Diseases in animals other than cattle. Two cases of ulcerative lymphangitis in mules were treated. No cases of epizootic lymphangitis came under observation. The Protectorate, however, was practically denuded of ponies and mules during the War. No serious outbreaks of disease occured in sheep and goats. Mange was seen in goats in Busoga. In dogs cases of piroplasmosis were treated, but there were a very large number of relapses, and in one case, trypanblue had to be injected four times before a cure was attained. A disease resembling rabies was reported in Ankole, but no cases came under observation and apparently it rapidly died out. Several cases of infection of dogs with filaria came under observation and the disease was very fatal. Fowl diphtheria was very prevalent in June and July, 1919, and several outbreaks of fowl cholera occurred in Kampala later in the year. A few cases of tuberculosis were also encountered in fowls. The report concludes with the returns of the Kampala slaughterhouse and other miscellaneous information.